Appendix E.G

Response to Comments on Draft EIS
Agency Comments

G1

DEPARTMENT OF THE AIR FORCE
PACIFIC AIR FORCES

MAY 13 2003

Ms. Hanh Gold
NEPA Compliance Coordinator
U.S. Environmental Protection Agency
1200 Sixth Avenue, OW-130
Seattle, WA 98101

Colonel Jerry I. Siegel
Commander, 611 Air Operations Group
9480 Pease Avenue, Ste 102
Elmendorf AFB, AK 99506-2100

Dear Ms. Gold

As the airspace director for 11th Air Force in Alaska, we are sensitive to land management issues involving activity below the military training airspace in which we use. The Pogo mine lies in the southern portion of Yukon 1 Military Operations Area (MOA), classified by the FAA as Special Use Airspace. We have been working closely with Teck-Pogo management staff for over four years with respect to managing our training operations in the mine's vicinity. We are writing to comment favorably to the Draft Environmental Impact Statement (EIS), with the preferred alternative as modified and outlined in the State of Alaska's Department of Environmental Resources letter dated April 4, 2003.

Building a road will reduce the air traffic support currently required. We understand that once completed, air re-supply sorties will be reduced to approximately two per week. This will greatly reduce the likelihood of conflicts and will offer their support pilots greater opportunity to use our Special Use Airspace Information Service to facilitate deconfliction.

G1-1

However, we have one concern. The modified alternative will keep the first 23 miles of road open after the mine ceases operations. We understand and endorse the need for roads in our state. We don't have many. However, the Department of Defense and the Air Force in particular are facing training airspace encroachment issues all over the country (as evidenced by congressional testimony given on 1 Apr 03). This road will offer greater access to that part of the state for recreation, etc. With it will likely come noise complaints about our training activity. The remaining road will lie beneath the Birch MOA (floor 500' above ground) and Yukon 1 MOA (100' above the ground). The Alaska MOA EIS Record of Decision, 1 Apr 1997, levied several mitigated areas in this area on our training operations (Pogo mine was not one of them). Please remind the State of Alaska that we will work with them through established inter-agency processes, but it will be difficult to add any more mitigation to the training airspace should it ever be requested. Our national defense readiness will be impacted if we continue to add restrictions to the airspace.

Thank you for the opportunity to comment. This project is a worthy endeavor for the people of our state and it's economy. My staff has visited the mine site and can attest to the professionalism and environmental stewardship that Teck-Pogo staff possess. My point of contact is Captain Gary Rolf, (907) 552-4056, gary.rolf@elmendorf.af.mil.

Sincerely,

JERRY I. SIEGEL, Colonel, USAF

cc:
11 AF/CV
611 ASG/CC
AAL-500
AAL-530
AAL-004
HQ AF XOO-CA

COMMENT RESPONSE:

G1-1 Thank you for your comment.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

G2

May 19, 2003

RECEIVED
MAY 21 2003

Hanh Gold
NEPA Compliance Coordinator
US Environmental Protection Agency
1200 Sixth Ave. OW-130
Seattle, WA. 98101

Dear Ms. Gold:

The National Marine Fisheries Service (NMFS) has reviewed the Draft Environmental Impact Statement for the Pogo Gold Mine Project. NMFS review was focused on Appendix F.3, the Draft Essential Fish Habitat Assessment (DEFHA). NMFS concurs with the Environmental Protection Agency's (EPA) Assessment that "On the basis of the scope and nature of impacts expected from the project and mitigation measures identified above, no substantial adverse individual or cumulative effects of EFH are expected in the project area." NMFS supports the special conditions in the DEFHA proposed by EPA. Please contact Larry Peltz at (907) 271-1332 if you have any questions. G2-1

Sincerely,

Jonathan M. Kurland
Assistant Regional Administrator
for Habitat Conservation

COMMENT RESPONSE:

G2-1 Thank you for your concurrence.

ALASKA REGION - www.fakr.noaa.gov

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
ALASKA OPERATIONS OFFICE
Room 537, Federal Building
222 W. 7th Avenue, #19
Anchorage, Alaska 99513-7588

G3

April 22, 2003

MEMORANDUM

SUBJECT: Pogo Mine DEIS

FROM: Cindi Godsey
Alaska Mining Coordinator

TO: Hanh Gold
NEPA Compliance

The table below contains comments on the identified sections of the DEIS. The second table contains corrections and typographical errors that were noted as I read the document.

Page/Section	Issue Comments	
S-18/¶6 and 5-29/Direct Discharge	ADEC is not going to adopt a higher MCL for iron. What is actually pending is the removal of the applicability of secondary drinking water MCLs to the WQS. (There are several references to this topic in Chapter 4 that got it right).	G3-1
1-11/1.7.1	This section states how EPA and ADNR will use the EIS but not the Corps.	G3-2
1-12/ Storm water	Section 402 of the CWA is not applicable to non-point sources. Even though it may not seem to be, by definition storm water is a point source subject to 402(p).	G3-3

Printed on Recycled Paper

2

3-5	Goodpaster section page 3-4 says that the Goodpaster near the mouth is slow but has a relatively deep main channel but then on page 3-5, it says it is slow but relatively shallow Also page 3-5 says that the river has a well-established channel but on 3-4, and again on 3-62 (3.13.1 ¶1), it talks about the lower reaches becoming multi-channeled and highly meandering	G3-4
4-8	Tailings Disposal section discussion is present about the dam possibly overtopping 22 times in 1000 years but it doesn't mention the possibility of its overtopping 45 times in 1000 years as it does on page 2-58 and again on 4-45 The 45 times is attributed to the use of the off-river treatment works because there would be times that the river flow would be too low to withdraw water but it doesn't seem to account for the use of well water in the mixing chamber as stated would be done during low flows on page 2-58, ▹1, ✦5	G3-5
4-19/4.2.5 ▹1	says that a certain alternative would not cause impacts to WQ - but this isn't the WQ section, it is the groundwater section and the next ▹ talks about impacts to groundwater rather than to WQ	G3-6
4-41	Water Discharge/Development Phase section states "not suitable for anadromous fish spawning" but the WQS at 18 AAC 70.255(h) says "For streams and rivers, or other flowing fresh water subject to (e)(3) of this section, a mixing zone will not be authorized in an area of (1) anadromous fish spawning; or (2) resident fish spawning redds for Arctic grayling, northern pike, . . ." Is the area not suitable for any type of spawning or only anadromous spawning? Because if it would be suitable for resident fish spawning redds then a mixing zone wouldn't be allowed. This is also an issue with Alternative 3 on page 4-90.	G3-7

3

4-45/4.3.5	Last line "the cumulative impacts of additional mines would be low" should be changed to "the cumulative impacts of additional mines in compliance with the proper permits would be low"	G3-8
4-170 ¶3	this says that the shift change would entail 2 - 30 minute periods but in the noise section (last ¶ of page 4-62) it says "each of the hour-long periods" when discussing shift change	G3-9

Page/Section	Typographical Comments	
S-18/¶2	visual impacts would removed	G3-10
S-18/¶4	"underground well injection" should probably be underground injection well	G3-11
S-20/¶5	interruptions for remainder of year	G3-12
1-1/¶3	mentions the road twice (at least it is the same length both times)	G3-13
1-2/1.3 ¶4	In late 1997, The applicant	G3-14
	pages 1-4 and 1-6 are blank	G3-15
2-13 ¶3	44 and 70 fights per week (pretty rough place!)	G3-16
2-20 ¶1	dry-tack	G3-17
2-31/2.3.14	root wads, and, growth media	G3-18
2-70	text for section 2.5.1 ends without punctuation - is there more?	G3-19
3-1/3.1.2	I know that terrane and terrain mean the same thing but should one spelling be used throughout the document - both are used	G3-20
3-3/¶2	looks and reads like a line of text may be missing	G3-21
3-36	Goodpaster River Valley section ¶1 contains a font change	G3-22

4

Page/Section	Typographical Comments	
3-40/3.9.2 ¶1	Noise levels for general mining operations noise levels used in this analysis are stated as sound pressure levels	G3-23
/3.9.3 ¶2	approximately3	G3-24
3-43 top	ATVs) (both recreational - there is no opening (on the previous page to match with the closing one after ATVs	G3-25
3-72/¶2	Tech-Pogo	G3-26
3-97/¶1	activity military personal (perhaps active military personnel?)	G3-27
¶3	(those that draws new money . . .)	G3-28
3-103	Education section the text states that the Healy Lake School was K-9 but the table says it was K-12	G3-29
3-158	Tanana River section offers salmon, , grayling	G3-30
4-9	Mill & Camp section "discharge of Liese Creek" should it be "flow?"	G3-31
4-20/4.3.1 ¶2	into Shaw Creek or tributary could - "a tributary"	G3-32
4-35	Disposition section ▹2 BMPs instead of BMPS	G3-33
4-69	Contributions to Abundance . . . section Similarly, dust, particles	G3-34
4-87/4.8.1	Routine and accidental spills of petroleum products - since when are spills routine?	G3-35
4-92 ¶4	process faculties	G3-36
4-95/4.9.1	✦ Habitat - development pf residential	G3-37

5

Page/Section	Typographical Comments	
4-118	Delta Area Housing ¶3 150 personnel . . . including 50 military and 150 civilian -- another look at the numbers may be in order.	G3-38
4-123	Delta Area Public Services ¶3 "population, according data published"	G3-39
4-125	Socioeconomic Impacts . . . Borough ¶2 "$3million $4million in payroll"	G3-40
4-129	Last ¶ in Borough Formation "Fairbanks North Star, , Denali, and Matanuska-Susitna"	G3-41
4-163/4.16.3	Alternative 2 Power Supply "semi-primitive mororized"	G3-42
4-182/4.19.2	▹ 1 - measures that would used to build	G3-43
4-183/4.20.1	"substitute resources of environment" should "of" be "or"?	G3-44

COMMENT RESPONSE:

G3-1 The text in the Summary and Section 5.2.2 has been changed to reflect the comment.

G3-2 Text has been added to Section 1.7.1 to reflect the comment.

G3-3 Text in Section 1.7.2 has been redrafted to reflect the comment.

G3-4 Text in Section 3.5.1 has been redrafted to reflect the comment.

G3-5 Discussion of overtopping 45 times in 1000 years is not appropriate in Section 4.1.2 because this section describes the Applicant's Proposed Project and not the off-river treatment works. A discussion of overtopping 45 times in 1000 years is appropriate, however, in Section 4.1.3, and such a discussion has been included there.

The use of supplemental groundwater for addition to the off-river-treatment works process was not included in the frequency estimate of RTP overtopping. Using supplemental groundwater for dilution in the treatment works would allow a greater overall volume of water to be discharged during low flows in the Goodpaster River. Hence, the estimate of the RTP over topping 45 times in 1000 years for this discharge option is conservative.

G3-6 Text in Section 4.2.5 has been redrafted to reflect the comment.

G3-7 Text in Sections 4.3.3 and 4.8.3 has been redrafted to reflect the comment.

G3-8 Text in Section 4.3.5 has been redrafted to reflect the comment.

G3-9 Text in Section 4.17.4 has been redrafted to reflect the comment.

G3-10 Text in Section S.12.2 has been redrafted to reflect the comment.

G3-11 Text in Section S.12.2 has been redrafted to reflect the comment.

G3-12 Text in Section S.12.3 has been redrafted to reflect the comment.

G3-13 Text in Section 1.1 has been redrafted to reflect the comment.

G3-14 Text in Section 1.3 has been redrafted to reflect the comment.

G3-15 This has been corrected in the FEIS.

G3-16 Text in Section 2.3.3 has been redrafted to reflect the comment.

G3-17 Text in Section 2.3.9 has been redrafted to reflect the comment.

G3-18 Text in Section 2.3.14 has been redrafted to reflect the comment.

G3-19 Text in Section 2.5.1 has been redrafted to reflect the comment.

G3-20 Text in Sections 3.1.2 and 3.17.1 has been redrafted to reflect the comment.

G3-21 Text in Section 3.5 has been redrafted to reflect the comment.

G3-22 Font in Section 3.7.3 has been changed to reflect the comment.

G3-23 Text in Section 3.9.2 has been redrafted to reflect the comment.

G3-24 Text in Section 3.9.3 has been redrafted to reflect the comment.

G3-25 Text in Section 3.9.5 has been redrafted to reflect the comment.

G3-26 Text in Section 3.13.1 has been redrafted to reflect the comment.

G3-27 Text in Section 3.16.2 has been redrafted to reflect the comment.

G3-28 Text in Section 3.16.2 has been redrafted to reflect the comment.

G3-29 Table 3.16-12 has been changed to reflect the comment.

G3-30 Text in Section 3.21.1 has been redrafted to reflect the comment.

G3-31 Text in Section 4.1.2 has been redrafted to reflect the comment.

G3-32 Text in Section 4.3.1 has been redrafted to reflect the comment.

G3-33 Text in Section 4.3.2 has been redrafted to reflect the comment.

G3-34 Text in Section 4.6 has been redrafted to reflect the comment.

G3-35 Text in Section 4.8.1 has been redrafted to reflect the comment.

G3-36 Text in Section 4.8.3 has been redrafted to reflect the comment.

G3-37 Text in Section 4.9.1 has been redrafted to reflect the comment.

G3-38 Text in Section 4.11.1 has been redrafted to reflect the comment.

G3-39 Text in Section 4.11.4 has been redrafted to reflect the comment.

G3-40 Text in Section 4.11.4 has been redrafted to reflect the comment.

G3-41 Text in Section 4.11.5 has been redrafted to reflect the comment.

G3-42 Text in Section 4.16.3 has been redrafted to reflect the comment.

G3-43 Text in Section 4.19.2 has been redrafted to reflect the comment.

G3-44 Text in Section 4.20.1 has been redrafted to reflect the comment.

G4

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
1200 Sixth Avenue
Seattle, Washington 98101

May 13, 2003

Reply To Attn Of: CEJ-164

FROM: Susanne Salcido
Environmental Justice Coordinator
Office for Civil Rights, Enforcement and Environmental Justice

TO: Hanh Gold
Environmental Engineer
Office of Water

Subject: Draft Environmental Impact Statement for the Pogo Gold Mine Project

I have reviewed the Pogo Gold Mine Project Draft Environmental Impact Statement (DEIS) for its compliance with Environmental Justice issues. I also reviewed the document in conjunction with the original comments on the Preliminary Draft Environmental Impact Statement (PDEIS) reviewed by Mike Letourneau, formerly of this Office.

Mr. Letourneau commented that the PDEIS needed to provide the rationale for identifying the Native American, Russian and Korean populations as minority and/or low income populations. Our review indicates that this was addressed adequately in the DEIS. G4-1

Mr. Letourneau commented that the PDEIS needed to assure that the concerns expressed by those that will be impacted are reflected in the proposed alternatives and mitigation measures, to guarantee that Environmental Justice concerns are properly addressed. Our review indicates that this was addressed adequately in the DEIS. G4-2

Mr. Letourneau commented that the PDEIS needed to provide additional definitions of subsistence, from federal agencies and Native American communities, because additional definitions will help assure the reader that the impacts on communities that rely on subsistence activities, have been properly identified and addressed. Our review indicates that this was addressed adequately in the DEIS. G4-3

If you have any questions regarding these comments, or need additional information, please feel free to contact me at extension 3-1687.

COMMENT RESPONSE:

G4-1 Thank you for your comment.

G4-2 Thank you for your comment.

G4-3 Thank you for your comment.

Printed on Recycled Paper

G5

United States Department of the Interior
Fish and Wildlife Service
FAIRBANKS FISH AND WILDLIFE OFFICE
101 12th Ave., Box 19, Room 110
Fairbanks, Alaska 99701
May 9, 2003

RECEIV...
U.S. EPA REGION 10
OFFICE OF WATER

Hanh Gold
NEPA Compliance Coordinator
U.S. Environmental Protection Agency
1200 Sixth Avenue, OW-130
Seattle, WA 98101

Re: Draft Environmental Impact Statement for Pogo Gold Mine

Dear Ms. Gold:

The U.S. Fish and Wildlife Service has reviewed EPA's Draft Environmental Impact Statement (DEIS) for the Pogo Gold Mine Project. Teck-Pogo Inc. proposes to develop the underground Pogo Mine on State of Alaska land in the Goodpaster River valley approximately 38 miles northeast of Delta Junction, Alaska. The geologic resource of the mine is approximately 5.6 million ounces of gold. The proposed mine would use crushing, grinding, gravity concentration, floatation, and cyanide leaching processes to extract the gold. The tailings would be placed back underground and in an engineered disposal area in the Liese Creek valley. The mine would operate 24 hours a day, 365 days a year. Mine development is projected to begin in fall, 2003 with construction lasting approximately 2 years and have an operating life of approximately 11 years. At the end of mine life, Teck-Pogo proposes to seal and reclaim the mine. The Agency Preferred Alternative combines the mine access route and powerline from Alternative 2 (the Shaw Creek Hillside All-Season Road) and the water treatment system from Alternative 4 (the Off-River Treatment Works). Under this alternative, the 49-mile Shaw Creek Hillside All-Season Road would be open to general public use for the first 23 miles where the road is within or adjacent to the Tanana Valley State Forest, and then closed for the remaining 26 miles to the mine. The last 26 miles would be reclaimed, and the first 23 miles of the road would be retained permanently. A 50-mile power line would parallel the road. Mine site facilities include a mill and camp complex, dry stack tailings pile and recycle water tailings pond, 3,000-foot airstrip located on the Goodpaster Valley floor just north of the mouth of Leise Creek, gravel pits, laydown and fuel storage areas, and a local network of roads.

We have the following comments on the DEIS:

2.3 Applicant's Preferred Alternative

Alternative 2 is the Applicant's Proposal. The Agency's Preferred Alternative is discussed in Section 5 - Agency Determination of Preferred Alternative. Section 2.3 should be changed from G5-1

"Applicant's Preferred Alternative" to "Applicant's Proposal" to eliminate confusion regarding the Preferred Alternative. As the DEIS is written, there appears to be two preferred alternatives - the Applicant's and the Agency's. There should only be one Preferred Alternative. Potential impacts of the Preferred Alternative, as compared to other alternatives, should be the focus the final EIS. G5-1 CONT'D.

4.12 Land Use

Options for permanent and temporary access roads are discussed in sections 4.12.4 and 4.12.5. The Agency Preferred Alternative modified the Applicant's Proposal (Alternative 2) to include reclamation of roughly one-half of the proposed 49-mile access road. The DEIS effectively analyzes temporary and permanent access road options, but lacks a thorough analysis of the newly proposed combination of temporary and permanent access in the Agency Preferred Alternative. The FEIS should address the direct, indirect and cumulative effects of the preferred access alternative. G5-2

4.8 Fish and Aquatic Habitat

Section 4.8.2. As stated in the DEIS and PDEIS, the Goodpaster River is a high-value fish-bearing stream. The proposed location of the 3,000 ft. airstrip abuts an outside bend of the Goodpaster River. Outside bends of rivers are very susceptible to erosion and bank failure during floods and high sediment discharge. Clearing for the airstrip could lead to river channel changes with increased downstream sedimentation and possible loss of spawning and macroinvertebrate habitat. Erosion resulting from airstrip construction could have a major local impact on the Goodpaster River if it occurred during salmon spawning. On page 4-89, the DEIS states that from the perspectives of local topography and flight safety, the airstrip location cannot meet both the Service requested 300-foot buffer and the FAA runway alignment requirements. The applicant proposes to use mitigation and reclamation measures to maintain river bank stability and to prevent encroachment on the airstrip. The most effective way to stabilize a river bank is to maintain a vegetated buffer. A minimum buffer of 50 feet would help stabilize the river bank. The airstrip should be engineered to include a vegetative buffer ranging from 50 to 300 feet depending on runway alignment requirements. Trimming willow to a 3 foot height along the bank will keep roots in tact and stabilize the river bank while providing visibilty. Rather than using rip rap to stabilize the bank, the Service asks you consider, as you work to mitigate impacts, leaving the bank vegetated and utilizing methods discussed in the enclosed paper, *The Cross-Vane, W-Weir and J-Hook Vane Structures... Their Description, Design and Application for Stream Stabilization and River Restoration* by D. L. Rosgen, P.H. The in-stream structures discussed in this paper reduce near-bank shear stress and stream power while increasing center channel shear stress and stream power to retain both flood-flow and sediment transport capacity. Testing has shown that submerged vanes like J-Hooks not only redirect velocity away from the riverbank thereby reducing erosion, but improve fish habitat by creating slow-water pools downstream of the structures. G5-3

4.20 Mitigation, Reclamation and Monitoring

2

Table 4.20-1 effectively summarizes resource protection measures that are being proposed by Teck-Pogo Inc. The Service commends Teck-Pogo Inc. for their recognition of the importance of this area to fish and wildlife, and we support the proposed mitigation measures. We have the following suggestions for improving the mitigation plan.

Wildlife. Mitigation measure #1 states, "Gravel pits excavated and maintained with appropriate pit slopes to ensure stability and avoid wildlife entrapment." The Service suggests you consider the following additional mitigation for creating and enhancing productive wildlife habitat when reclaiming gravel pits:

- Design reclaimed gravel pits to include a shallow littoral zone, extending at least 20 feet from shore with a maximum underwater shoreline slope of 20H:1V with a maximum water depth of 12" at 20 feet from shore. Extreme shallows (1-3") should be a portion of the 20-foot littoral zone to provide habitat for wading birds and shorebirds. G5-4
- The perimeter of the reclaimed gravel pit should be irregularly-shaped with coves, spits and peninsulas to provide a diversity of shoreline habitat.
- Overburden stockpiled from the gravel pit operation should be returned to the pit, taking care to spread a portion of it within the littoral zone. Organics from the overburden will facilitate plant growth.

Subsistence. Mitigation measure #1 states, "All-season road open only to Pogo-related vehicles. Gated, video monitored, and patrolled to ensure compliance." With the new Agency Preferred Alternative, the all-season road would be open to general public use for the first 23 miles where the road is within or adjacent to the Tanana Valley State Forest, and then closed for the remaining 26 miles to the mine. The last 26 miles would be reclaimed, and the first 23 miles of the road would be retained permanently. Mitigation for subsistence should be addressed under the Agency Preferred Alternative. G5-5

As we stated in our September 7, 2000 and September 25, 2002 letters, there are no threatened or endangered species in the project area, and thus impacts to listed species are not anticipated. G5-6

We appreciate this opportunity to comment. Please contact Elaine Gross at 456-0209 should you have any questions concerning these comments.

Sincerely,

Steven A. Lewis
Field Supervisor

3

cc: Doug Mutter, DOI, Anchorage
Cindi Godsey, EPA, Anchorage
Leroy Phillips, COE, Anchorage
Ed Fogels, ADNR, Anchorage
Steve McGroarty, ADNR, Fairbanks
Jack Winters, ADF&G, Fairbanks
Pete McGee, ADEC, Fairbanks
Karl Hanneman, Alaska Regional Manager, Teck Resources, Inc., 3520 International St, Fairbanks, 99701

Attachment: *The Cross-Vane, W-Weir and J-Hook Vane Structures... Their Description, Design and Application for Stream Stabilization and River Restoration* by D. L. Rosgen, P.H.

Literature Cited

Rosgen, David L. 2001. The Cross-Vane, W-Weir and J-Hook Vane Structures... Their Description, Design and Application for Stream Stabilization and River Restoration. In 2001 Wetlands Engineering & River Restoration Conference, August 27-31, Reno, NV.

G5

The Cross-Vane, W-Weir and J-Hook Vane Structures...Their Description, Design and Application for Stream Stabilization and River Restoration

D. L. Rosgen, P.H.*

* Professional Hydrologist, Wildland Hydrology, Inc. 1481 Stevens Lake Road. Pagosa Springs, Colorado 81147; PH 970-731-6100; wildlandhydrology@pagosa.net

Abstract

The descriptions, design specifications, placement locations, spacing and various applications of Cross-Vane, W-Weir and J-Hook Vane structures are presented. These structures were developed and subsequently applied to: 1) establish grade control, 2) reduce streambank erosion, 3) facilitate sediment transport, 4) provide for irrigation diversion structures, 5) enhance fish habitat, 6) maintain width/depth ratio, 7) improve recreational boating, 8) maintain river stability, 9) dissipate excess energy, 10) withstand large floods, 11) maintain channel capacity, 12) be compatible with natural channel design, and 13) be visually acceptable to the public.

Relations to determine the minimum size of rock for these structures are presented based on bankfull shear stress. Drawings for each structure are provided that display appropriate use of footers, cross-section shape, profile shape, appropriate channel locations, angles, slopes, spacing and elevations. Velocity isovels are presented to describe changes in the distribution of energy produced by the structures. The structures all reduce near-bank shear stress and stream power, while increasing center channel shear stress and stream power to retain both flood-flow and sediment transport capacity. These structures have been installed on 14 rivers with bankfull widths varying from 9m (Lower Blanco River in Southwestern Colorado) to 150m (Bitterroot River in Northwestern Montana) and slopes varying from 0.05 to .0003 and in bed material ranging from cobble and gravel to sand bed streams. Since 1986, the author has restored and monitored a wide variety of stream types involving over 48 km of rivers and evaluated various structure performance following major floods. This monitoring has resulted in the development, implementation and assessment of the Cross-Vane, W-Weir and J-Hook vane structures.

Introduction

Structures in river engineering are designed to help stabilize channel boundaries. However, monitoring their effectiveness have indicated that many structures, contrary to the intended design, caused river instability. Structures are often selected and installed without an understanding of sediment transport and violate the dimension, pattern and profile of the stable river. Relations for canal design based on rigid boundary theory, clear water discharge, and uniform flow have been implemented on natural channels, with less than effective results. Work conducted by Leopold, et al, (1964) found that river form is associated with an integration of eight interrelated variables, that if any one variable is changed, it sets up mutual, concurrent adjustments of the other variables in the stream system until a new quasi-equilibrium is reached (stability). The eight variables are slope, width, depth, velocity, discharge, boundary roughness, size of sediment transported, and concentration of sediment. The variables can be integrated into morphological relations for stable natural rivers as described by "reference reach" by stream type

G5

(Rosgen, 1998). Structures are often placed in rivers in an attempt to correct some of the adverse effects of channel adjustment due to instability. Unfortunately, many structures are often installed to "patch a symptom" rather than achieve the stable channel form. Appropriately used structures can assist in maintaining the stable dimension pattern and profile (Rosgen, 1996).

River engineering structures need to be incorporated with a clear understanding of the river variables that constitute the stable form. Structure failures are generally associated with designs incompatible with the "rules of the river". For example, cross-channel check dams decrease energy slope upstream of the structure. Data from natural rivers indicate a negative power function relation between sinuosity and slope (Figure 1), thus when slope is decreased there is a corresponding increase in sinuosity through lateral migration following bank erosion. Most failures of check dams occur when they are "out flanked" by the river through lateral adjustment upstream of the structure. Consequently, many check dams often accelerate excess bank erosion. Check dams generally decrease upstream velocity, slope, and depth, increase roughness, and induce sediment deposition. These changes lead to instability and contribute to the failure of the structure. Structures have also failed due to excessive bedload deposition that leads to a loss of channel capacity and subsequent change in the stable dimension, pattern and profile of the river.

Streambank stabilization structures proliferate as bank erosion accelerates. Most of the structures implemented involve "hardening" the banks. Changes in near-bank stress and/or stream power associated with unstable channels can accelerate bank erosion.
Work conducted by Parker (1978), and Bathurst (1979), described secondary circulation patterns and the distribution of boundary shear stress in both straight and meandering rivers. Ikeda, et al, (1988), described the erosion and transport of grains from the bank region to the center of the channel as a result of bank erosion. They also described the process of lateral momentum transfer due to turbulence that resulted in eddy diffusion and induced net lateral transport of longitudinal fluid momentum from regions of high momentum to regions of low momentum. These processes resulted in a lateral redistribution of bed shear stress. Secondary cells associated with down welling (high boundary shear stress) and upwelling (low boundary shear stress) occur in the near-bank region creating very high velocity gradients (Bathhurst, et al, 1979). Boundary shear stresses associated with high velocity gradients, can accelerate erosion rates, and are shown in the velocity isovel constructed from vertical velocity profiles (Figure 2). The streambank erosion prediction methodology developed by Rosgen (1996, 2001), utilizes computations of near-bank stress for assessing various erosion rates. Any structures that can reduce near-bank stress will reduce bank erosion by several orders of magnitude.

New attempts at similar problems

To offset near-bank forces to reduce streambank erosion, Paice and Hey (1989) installed submerged concrete vanes on the outside of meander bends to control secondary circulation and redirect river currents to decrease boundary shear stress in the outer bank region. These attempts were successful in reducing erosion by redirecting erosive currents in the near-bank region. Iowa Vanes (Ogdaard and Mosconi, 1987) were previously used to redirect currents away from streambanks to reduce accelerated erosion. Submerged vanes were installed and tested by Hey (1992) not only to re-direct velocity distribution but to also provide improved fish habitat.

G5

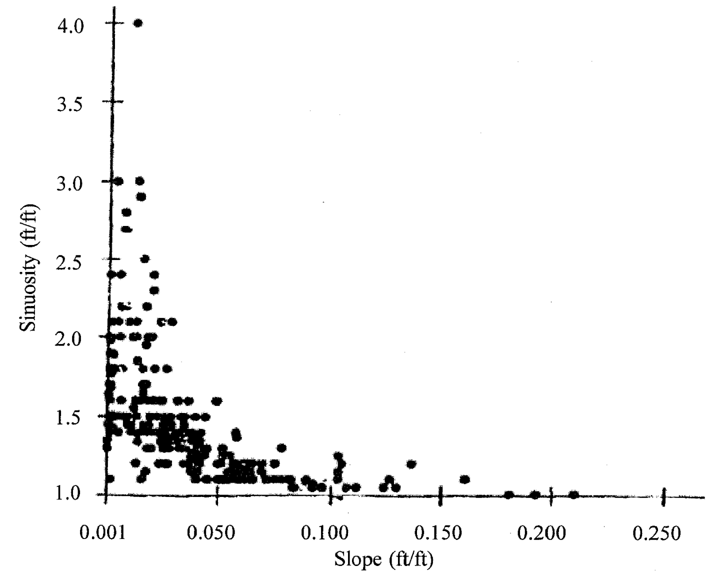

Figure 1. Relation of sinuosity to slope for natural rivers

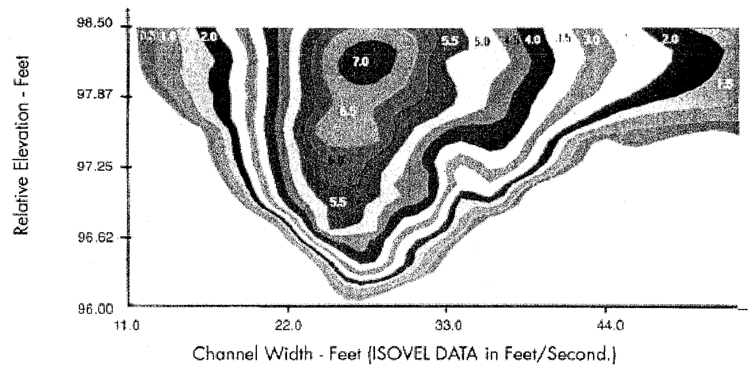

Figure 2. Velocity isovels for a "C3" stream type reach showing variations in velocity distribution (Rosgen, 1996, pg 6-42).

Structures that modify velocity distribution such as deflectors, bank barbs, spur dikes and other similar designs often accompany "bank hardening." The US Army Corps of Engineers recently developed bendway rock weirs (Derrick, et al, 1994). This structure points slightly upstream at a departure angle of 60-70 degrees from a tangent line from the bank. The intent of the bendway weir was initially to "scalp" point bars and re-locate the thalweg to the inside of the bend for navigation. In addition, this structure subsequently induced sediment deposition in the near-bank region. There is generally re-circulation, back eddy erosion on the upstream side of the structure due to the abrupt nature of re-directing the angle of attack of the near-bank velocity vectors. This structure has been installed on large rivers and has been effective in meeting its design objectives in many instances (Derrick, 1996).

Spur dikes and bank barb structures are common bank protection structures but generally produce an upstream and downstream re-circulation eddy that often increases bank erosion. This tends to occur when the thalweg is forced too far across the channel and/or the structures are oriented 45 to 90 degrees upstream from a tangent line to the bank. Bank barbs create a vertical vortices due to their abrupt angle to the bank that is often responsible for bank erosion and accelerated scour at the "point" of the barb. Rock and/or log deflector structures, pointing downstream, often direct the velocity vectors into the bank when flows overtop the structure increasing near-bank velocity gradients and causing accelerated bank erosion. Subsequently, some of these structures have created unexpected adverse adjustments in the channel.

Vortex Rock Weirs and Root Wads were installed in the 1980s for grade control, fish habitat and streambank erosion protection (Rosgen, 1996). After monitoring for approximately 15 years, the author determined that these structures produced back-eddy erosion during major floods resulting in streambank erosion and the loss of some structures. The problems of the Root Wad and Vortex Rock Weir structures were documented which subsequently led to major changes in their design.

As additional objectives of river engineering have evolved there has arisen a need for a "softer" substitute for streambank stabilization. The departure from traditional "hard" procedures has been slow but steady as the use of natural materials and methods have grown in popularity. This has, in turn, encouraged the pursuit of additional techniques to offset existing problems of various structures observed in the field. A properly designed river structure should meet more than one specific objective (such as grade control).
Structures should also:

1. Maintain the stable width/depth ratio of the channel;
2. Maintain the shear stress to move the largest size particle to maintain stability (competence);
3. Decrease near-bank velocity, shear stress or stream power;
4. Maintain channel capacity;
5. Ensure stability of structure during major floods;
6. Maintain fish passage at all flows;
7. Provide safe passage or enhance recreational boating;
8. Improve fish habitat;
9. Be visually compatible with natural channels;
10. Be less costly than traditional structures;

G5

11. Create maintenance-free diversion structures;
12. Reduce bridge pier/footer scour, road fill erosion and prevent sediment deposition.

The use of rip-rap, gabions, concrete lined channels, bin walls, interlocking blocks, groynes, Kelner Jacks, spur dikes, rock jetties, barbs, reinforced revetment, sheet piling, log cribs, concrete check dams, and loose rock check dams are not only expensive but often do not meet the above stated objectives for river structures. A central problem with riprap, gabions, toe rock protection and similar structures is the increase in near-bank velocity, velocity gradient, stream power, and shear stress. These problems often lead to either on-site failures or problems immediately upstream and/or downstream of the structures. This, in combination with their high cost, resultant poor fish habitat and "less than natural" appearance, led to the development in the early 1990's of the Cross-Vane, W-Weir and J-Hook Vane.

Description of Structures

Cross-Vane

General description

The design of the Cross-Vane structure is shown in plan, profile and section view in Figure 3. The Cross-Vane is a grade control structure that decreases near-bank shear stress, velocity and stream power, but increases the energy in the center of the channel. The structure will establish grade control, reduce bank erosion, create a stable width/depth ratio, maintain channel capacity, while maintaining sediment transport capacity, and sediment competence. The Cross-Vane also provides for the proper natural conditions of secondary circulation patterns commensurate with channel pattern, but with high velocity gradients and boundary stress shifted from the near-bank region. The Cross-Vane is also a stream habitat improvement structure due to: 1) an increase in bank cover due to a differential raise of the water surface in the bank region; 2) the creation of holding and refuge cover during both high and low flow periods in the deep pool; 3) the development of feeding lanes in the flow separation zones (the interface between fast and slow water) due to the strong downwelling and upwelling forces in the center of the channel; and 4) the creation of spawning habitat in the tail-out or glide portion of the pool.

The Cross-Vane is also a popular boating feature as kayakers routinely do "enders" and "surf" the vane portion of the structures installed on the Lake Fork of the Gunnison River near Lake City, Colorado and the San Juan River in Pagosa Springs, Colorado. The invert portion (center 1/3, see Figure 3) of the structure creates a standing wave, but is associated with a "run" immediately downstream of the invert. As a result the potential development of a dangerous re-circulation pool that traps "swimming paddlers" is eliminated. The structure "chutes" the swimmers and/ or their boats into the deep, low velocity pool approximately half a bankfull width below the invert.

G5

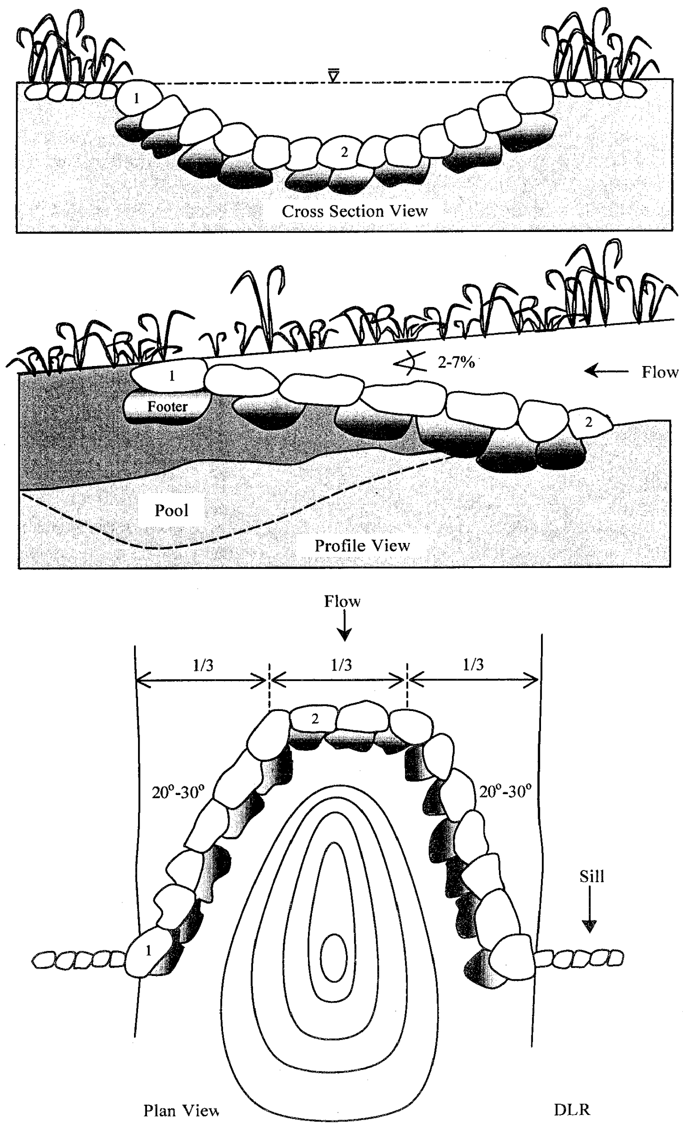

Figure 3. Cross section, profile and plan view of a Cross-Vane

G5

Major floods have tested the Cross-Vane structure such as the 1996 flood on the San Juan River in Pagosa Springs, which passed a flood stage of 3.5 meters above the top of the structures on a 0.005 slope. A detailed contour map prepared in 2000 demonstrates the channel shape and location of the deep pool (Figure 4). The structure did require post-flood maintenance and it is still performing properly as a diversion structure, a kayak playground and an excellent fly-fishing location where fisherman can be frequently observed. Although bedload transport of particle size up to 220 mm occurred during the flood, the pools did not fill. The strong downwelling currents in the center of the channel maintained a high bedload transport keeping the pool deep as evidenced in Figure 4.

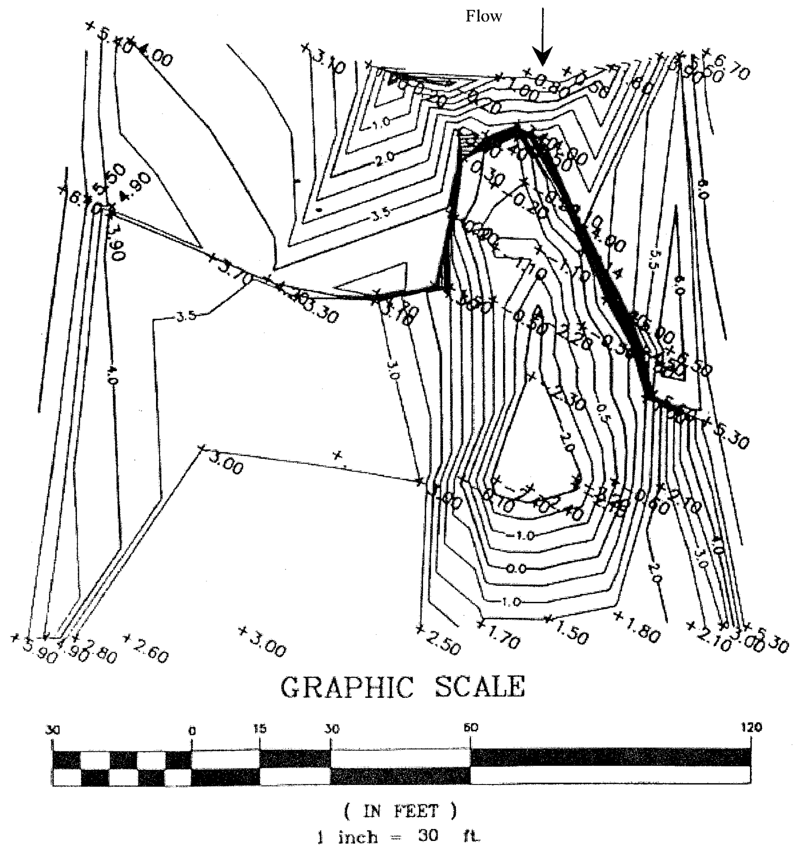

Figure 4. Contour map of Cross-Vane following major flood – San Juan River, CO.

G5

W-Weir

General Description. The design of the W-Weir (W as looking in the downstream direction) was initially developed to resemble bedrock control channels on larger rivers. Various rock weirs installed across larger rivers for fish habitat, grade control and bank protection often create an unnatural and uniform "line of rocks" that detracts from visual values. The W-Weir is similar to a Cross-Vane in that both sides are vanes directed from the bankfull bank upstream toward the bed with similar departure angles. From the bed at ¼ and ¾ channel width, the crest of the weir rises in the downstream direction to the center of the bankfull channel creating two thalwegs (Figure 5). The objectives of the structure are to provide grade control on larger rivers, enhance fish habitat, provide recreational boating, stabilize stream banks, facilitate irrigation diversions, reduce bridge center pier and foundation scour, and increase sediment transport at bridge locations. Double W-Weirs are constructed on very wide rivers and/or where two center pier bridge designs (three cells) require protection.
Habitat for trout is enhanced by maximizing usable holding, feeding and spawning areas. Fish hold in the multiple feeding lanes created by the two thalweg locations and pools. Various age classes of trout also hold in the deep glide created upstream of the structure and against both banks due to the increased depth and reduced velocity of flows in the near-bank region. Spawning habitat is created in the tail-out of the pools due to upwelling currents and a sorting of gravel bed material sizes preferred by trout.

J-Hook Vane

General Description. The J-Hook Vane is an upstream directed, gently sloping structure composed of natural materials. The structure can include a combination of boulders, logs and root wads (Figures 6-7) and is located on the outside of stream bends where strong downwelling and upwelling currents, high boundary stress, and high velocity gradients generate high stress in the near-bank region. The structure is designed to reduce bank erosion by reducing near-bank slope, velocity, velocity gradient, stream power and shear stress. Redirection of the secondary cells from the near-bank region does not cause erosion due to back-eddy re-circulation. The vane portion of the structure occupies 1/3 of the bankfull width of the channel, while the "hook" occupies the center 1/3.

Maximum velocity, shear stress, stream power and velocity gradients are decreased in the near-bank region and increased in the center of the channel. Sediment transport competence and capacity can be maintained as a result of the increased shear stress and stream power in the center 1/3 of the channel. Backwater is created only in the near-bank region, and the small departure angle gently redirects the velocity vectors from the near-bank region, reducing active bank erosion.

The scour pool in the center 1/3 of the channel provides energy dissipation and holding cover for fish. The flow separation zones, or "seams" of fast and slow water that mark the zones of downwelling and upwelling currents, are habitat features utilized by trout. The "hook" portion of the vane produces a longer, wider and deeper pool than that created by vane-only structures. The downstream pool dissipates energy and provides fish habitat. The 1/4 - 1/3 rock diameter gaps between the rocks associated with the hook creates a vortex or corkscrew flow that

G5

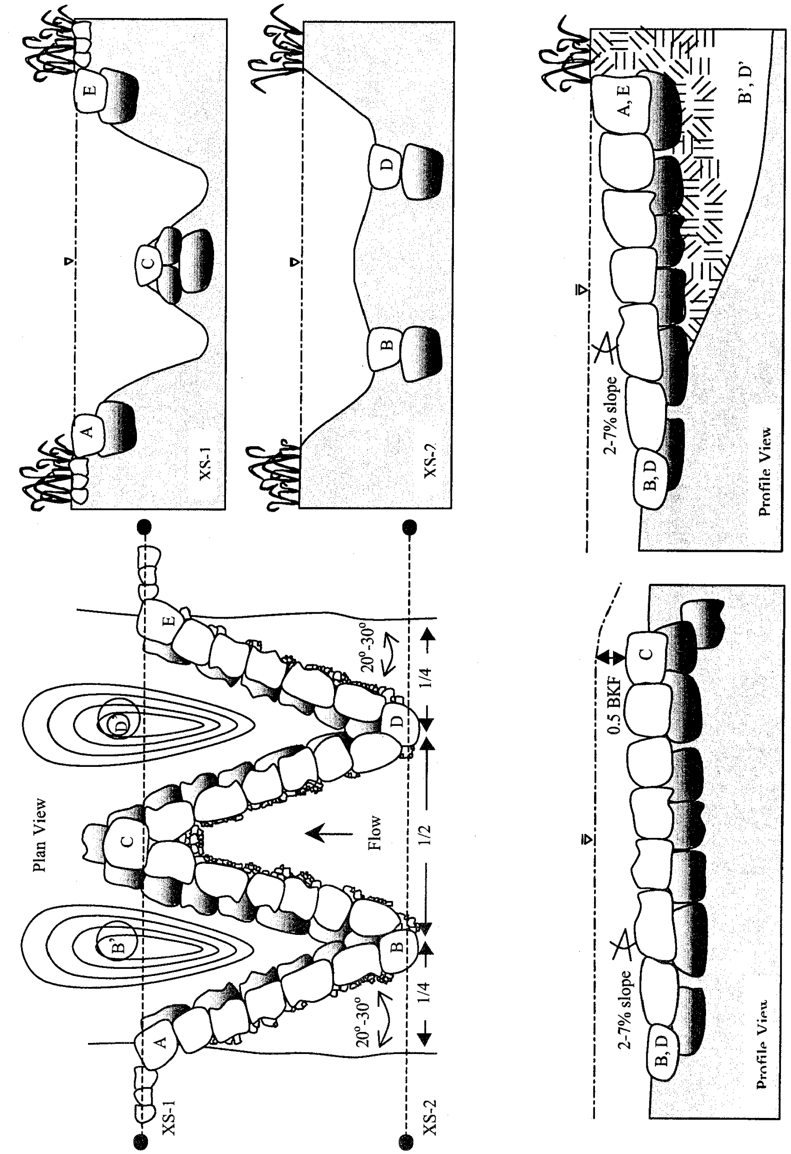

Figure 5. Plan, cross section, and profile views of the W-weir

G5

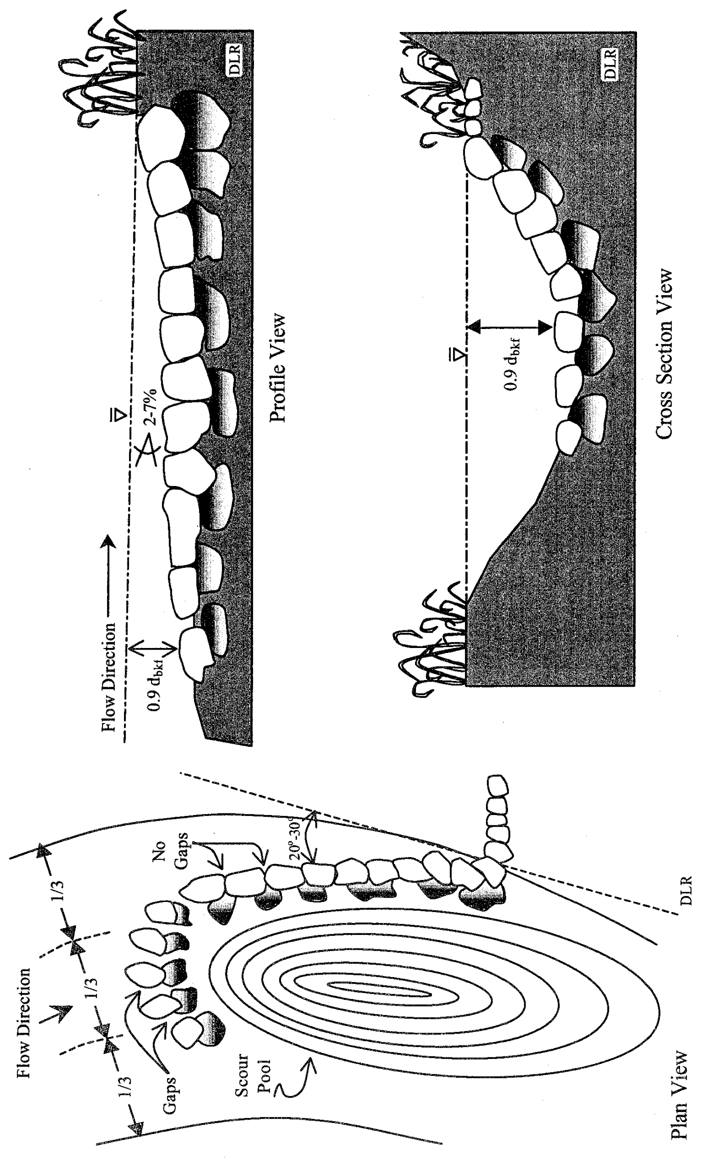

Figure 6. Plan, profile, and section view of the J-Hook Vane

10

G5

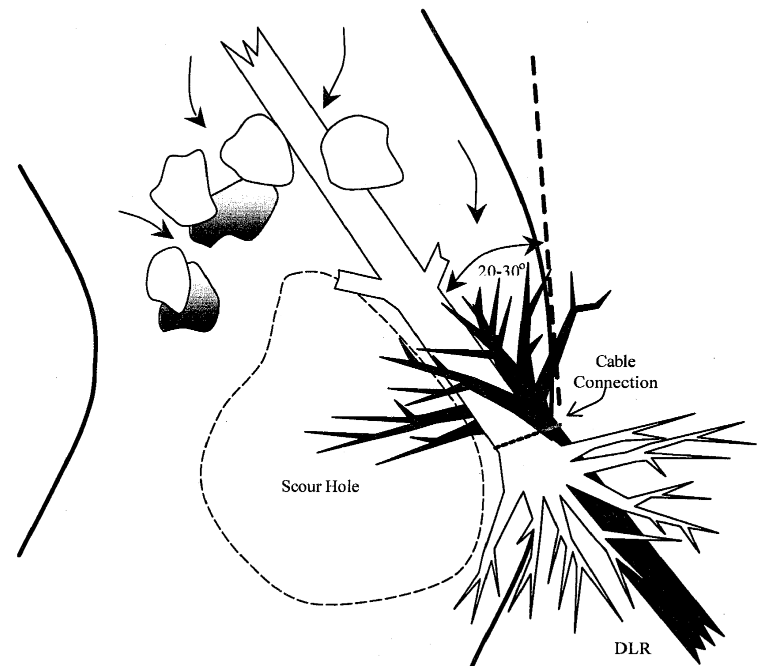

Figure 7. Root wad/log vane/J-Hook combo streambank stabilization and fish habitat structure

increases the "center-channel" shear stress. The center of the channel associated with the hook is efficient at transporting sediment, debris and improving channel capacity and sediment competence. The "shooting flow" associated with the hook portion of the structure provides for recreational boating in moderate to larger sized rivers. Width/depth ratios are maintained by decreasing bank erosion rate and increasing bankfull channel depth, even following major floods.

Design Specifications

Cross-Vanes, W-Weirs and J-Hook Vanes

Vane angle. The vane arm portion of all three structures is generally 20-30 degrees measured upstream from the tangent line where the vane intercepts the bank. The 20-degree angle provides the longest vane length and protects the greatest length of streambank. Variation from 20 to 30 degrees is often utilized in offset Cross-Vanes and/or W-Weirs whose asymmetry disproportionately shift more water to one side of the structure often used for irrigation

11

diversions. The flatter and smaller vane angle arm will extend farther upstream to intercept proportionately more water and increase the length of bank protected.

Vane slope. The slope of the vane extending from the bankfull stage bank should vary between 2-7 percent. Vane slope is defined by the ratio of bank height/vane length. For installation in meander bends, ratios of J-Hook Vane length/bankfull width is calculated as a function of the ratio of radius of curvature/bankfull width and departure angle (Table 1). Equations for predicting ratios of J-Hook Vane spacing/bankfull width on meander bends based on ratio of radius of curvature/bankfull width and departure angle is shown in Table 2. Vane length is the distance measured from the bankfull bank to the intercept with the invert elevation of the streambed at 1/3 of the bankfull channel width for either Cross-Vanes or J-Hook Vanes. For very large rivers, where it is impractical to extend the vane length to 1/3 of the bankfull width, vane slope is calculated based on the specified angle of departure and the ratio of bank height/vane length where the vane arm intercepts the proposed invert of the structure.

Table 1. Equations for predicting ratio of vane length/bankfull width (V_L) as a function of ratio of radius of curvature/width and departure angle, where W = bankfull width. (SI units)

Rc/W	Departure Angle (degrees)	Equation
3	20	$V_L = 0.0057\ W + 0.9462$
3	30	$V_L = 0.0089\ W + 0.5933$
5	20	$V_L = 0.0057\ W + 1.0462$
5	30	$V_L = 0.0057\ W + 0.8462$

Table 2. Equations for predicting ratio of vane spacing/width (Vs) as a function of ratio of radius of curvature/width and departure angle, where W = bankfull width (SI units)

Rc/W	Departure angle (degrees)	Equation
3	20	$Vs = -0.006\ W + 2.4781$
3	30	$Vs = -0.0114\ W + 1.9077$
5	20	$Vs = -0.0057\ W + 2.5538$
5	30	$Vs = -0.0089\ W + 2.2067$

The spacing of J-Hook Vanes can be increased by 0.40W if there exists a low bank erosion hazard rating (BEHI) of less than 30 (Rosgen, 1996, 2001).

Bank height. The structure should only extend to the bankfull stage elevation. If the bank is higher, a bankfull bench is constructed adjacent to the higher bank and the structure is integrated into the bench. The use of a Cross-Vane is shown in Figure 8 where a bankfull bench is created adjacent to a terrace bank.

Footers. The minimum footer depth at the invert for cobble and gravel bed streams is associated with a ratio of 3 times the protrusion height of the invert rock. This is applicable to all three structures and is shown in Figure 9 for a J-Hook Vane. For sand bed streams, the minimum depth is doubled due to the deeper scour depths that occur. All rocks for all three structures require footers. If spaces are left between the invert rocks for Cross-Vane and W Weirs, then the top of the footer rocks becomes the invert elevation for grade control. If no gaps are left, then the top of the surface rock becomes the base level of the stream.

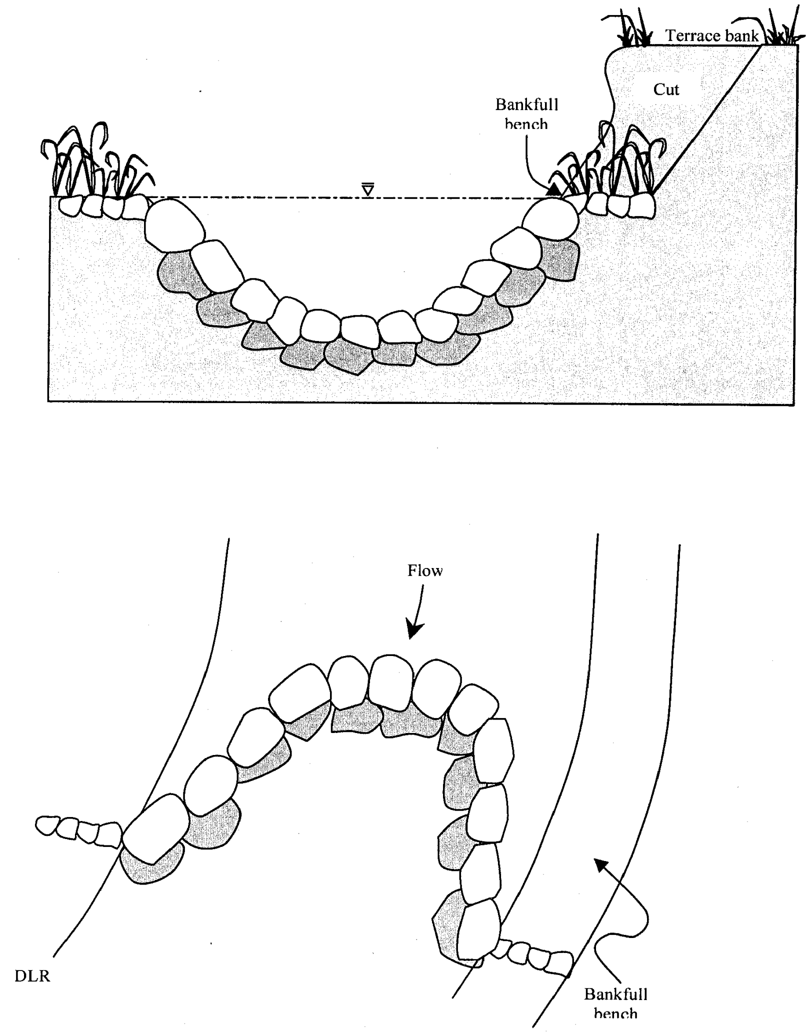

Figure 8. Example of a boulder Cross-Vane and constructed bankfull bench

G5

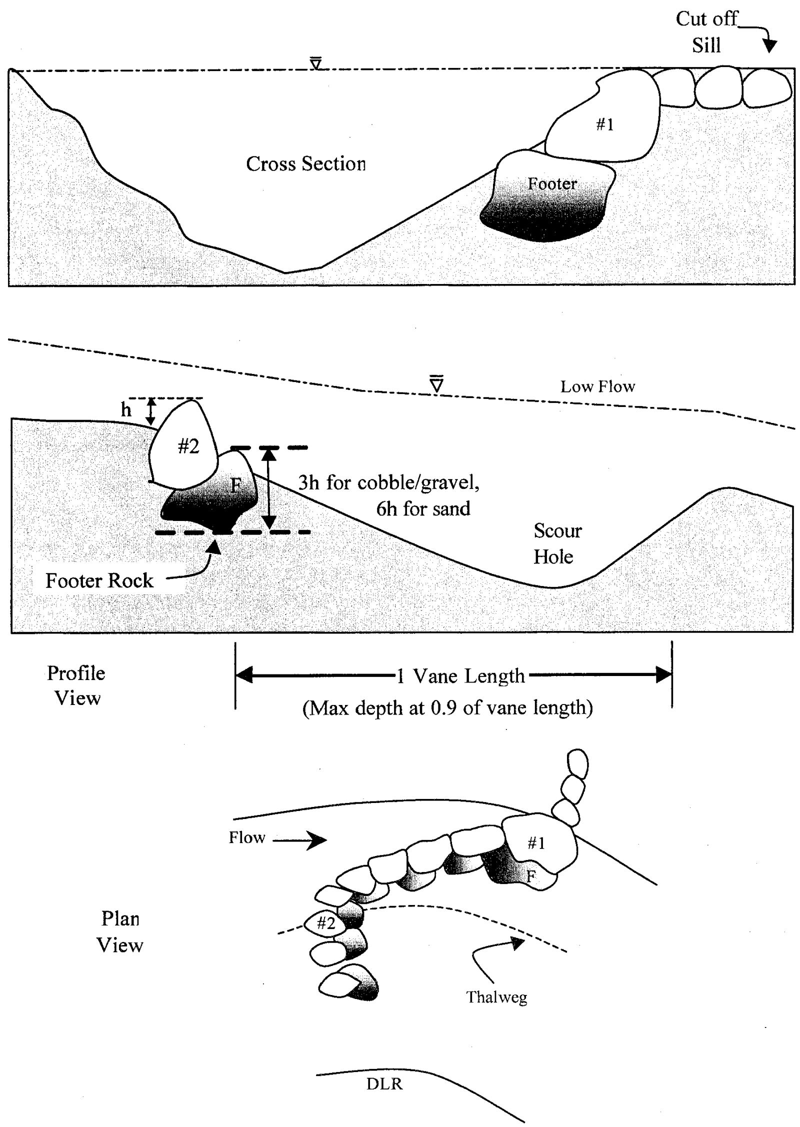

Figure 9. Locations/positions of rocks and footers in relation to channel shape and depths

G5

Rock size. The relationship of bankfull shear stress to minimum rock size used for all three structures is shown in Figure 10. The application of this empirical relation is limited to size of rivers whose bankfull discharge varies from 0.56 cms (20 cfs) to 113.3 cms (4,000 cfs). For example, appropriate minimum rock sizes for values of bankfull shear stress less than 1.7 kg/m^2 (0.35lbs/ft^2) are associated only with stream channel bankfull depths from 0.26 - 1.5m (2 - 5 ft). This relation would *not* be appropriate for applications outside the limits of the data for a river slope of 0.0003 and a mean depth of 6.1m, even though a similar shear stress results as in the example presented.

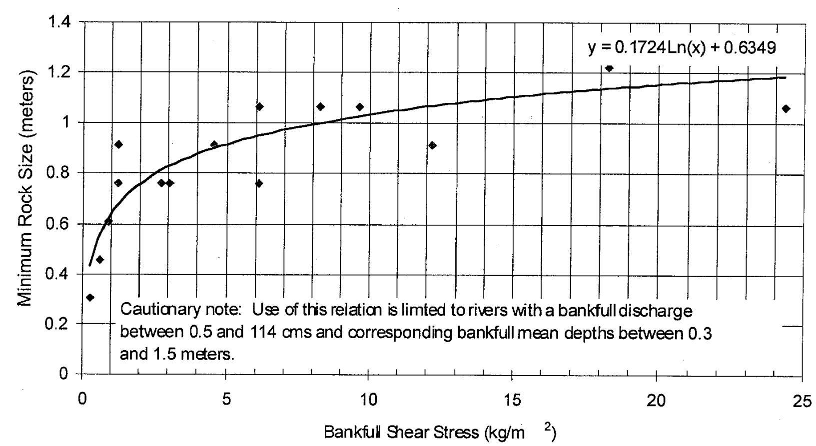

Figure 10. Minimum rock size as a function of bankfull shear stress

Materials. The Cross-Vane can be constructed with boulders, logs and a combination of both. A geotextile fabric is required to prevent scour under the structure when logs are used or when rocks are used in sand or silt/clay bed channels. The design using logs only and a duckbill anchor system is shown in Figure 11. Large flat rocks can be substituted for the duckbill anchor and cable to keep the logs in place.

Hydraulics. The center cell of Cross-Vane and J-Hook Vane structures generally contain 0.80 of the bankfull discharge. The left and right 1/3 cells of the structure each generally contain 0.3 of the mean velocity, 0.02 of the shear stress and 0.01 of the stream power of the entire bankfull channel. A velocity isovel showing the distribution of velocity over a J-Hook Vane on Turkey Creek, Colorado is shown in Figure 12. The Cross-Vane isovels are similar to those of the J-Hook Vane, as they distribute the velocity from the near-bank region to the center of the channel.

G5

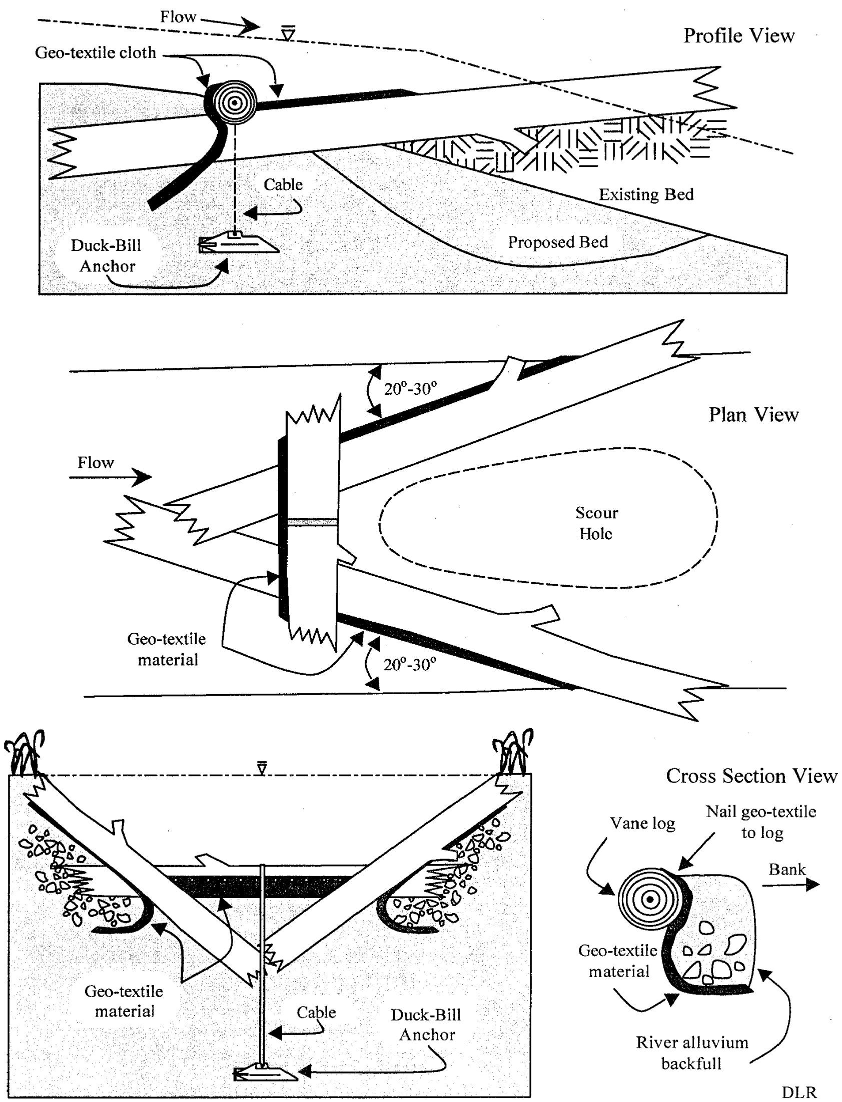

Figure 11. Cross-Vane using logs and a duck-bill anchor

G5

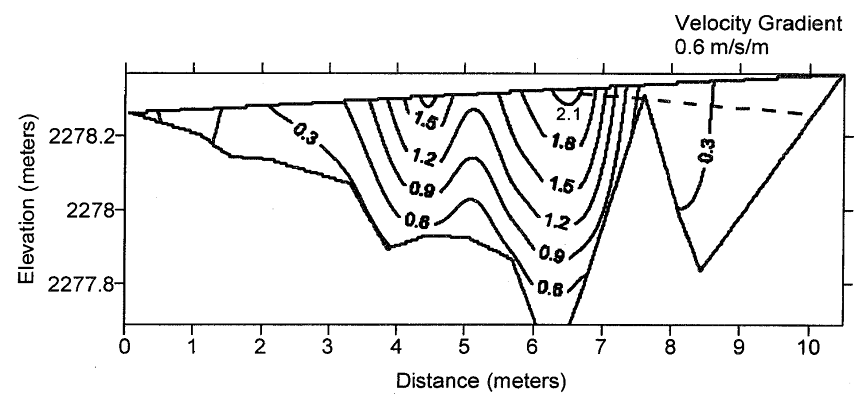

Figure 12. Velocity isovels of a J-Hook at Turkey Creek, CO (Velocity in meters/second)

Applications

Irrigation diversions. The use of a Cross-Vane for an irrigation diversion is shown in Figure 13. Cross-Vanes and W-Weirs have both been used successfully for irrigation structures. Both the Cross-Vane and W-Weir create a differential head in the near-bank region due to the flat slope of the vane leading to the bank. This condition provides the head to deliver water to the head gate at very low flows so that it is not necessary to construct sacrificial dams at low flows. When the head gate is closed during high flows, fine sediments often accumulate. To prevent the sediment deposition at the head gate and in the irrigation canal, a sediment sluice gate is installed so that the sediment is delivered back to the channel during normal high flows (Figure 13).

Grade control. The Cross-Vane is used to maintain base level in both riffle/pool channels, rapids-dominated stream types and in step-pool channels (Figure 14). One aspect of river restoration is associated with the conversion of incised rivers G and F stream types to B stream types (Rosgen, 1994,1996, and 1997). The Cross-Vane, as used for grade control, maintains the new width/depth ratio, entrenchment ratio, reduces bank erosion, dissipates energy and improves fish habitat. Spacing of the structures is based on a negative power function relationship of the ratio of pool spacing / bankfull width as a function of slope.

$$P_s = 8.2513\ S^{-0.9799}$$

Where P_s = the ratio of pool to pool spacing/bankfull width
S = channel slope in percent

This relationship was developed from natural channels and has a correlation coefficient (R^2) of 0.92 and is shown in Figure 15.

Bridge protection. Bridges constructed on a skew to the channel and/or placed on an outside bend often experience abutment scour and embankment erosion. This problem can be reduced by the placement of an offset Cross-Vane in the upstream reach. The vane on the outer bank in the bend has a flatter slope and smaller angle (20°), while the vane arm on the inside bank has a steeper slope and a larger angle (30°) (Figure 16). W-Weirs are particularly useful for reducing

G5

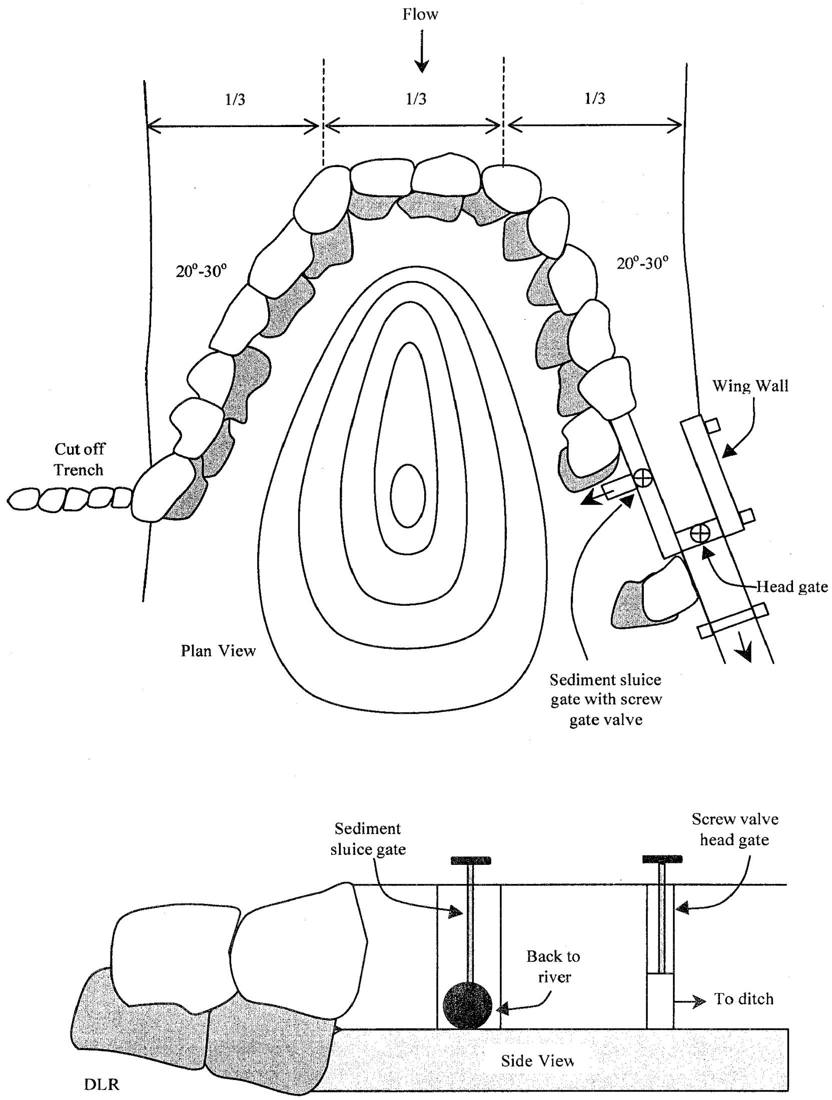

Figure 13. Example of a Cross-Vane/irrigation head gate-sediment sluice

18

G5

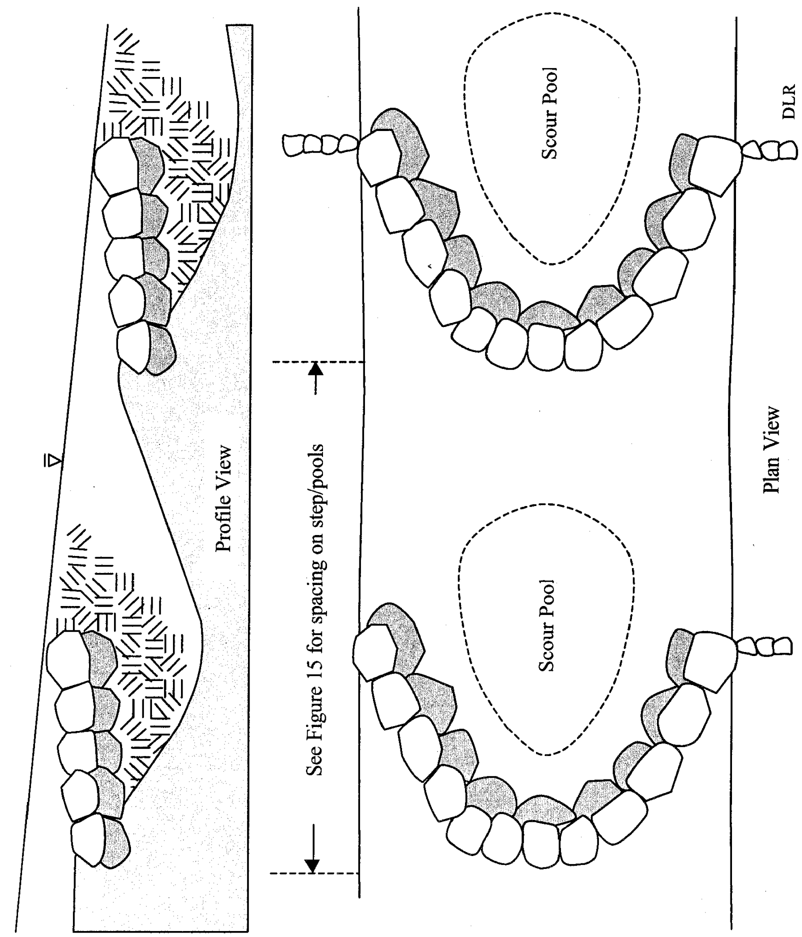

Figure 14. Use of Cross-Vane for step/pool restoration

19

G5

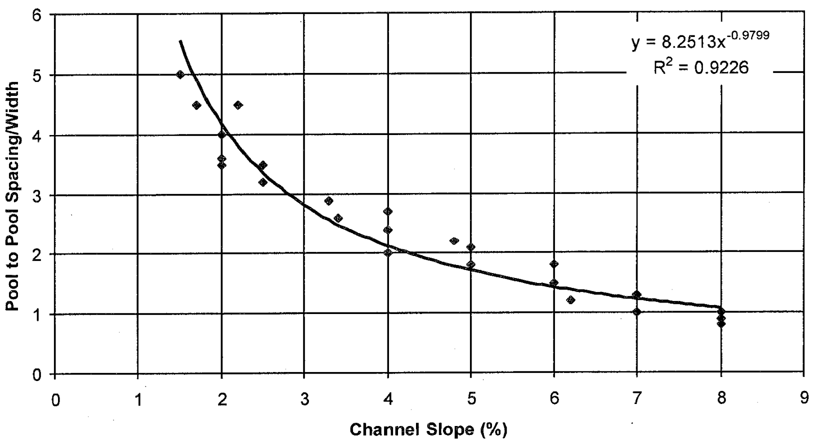

Figure 15. Ratio of pool spacing to bankfull width as a function of channel slope

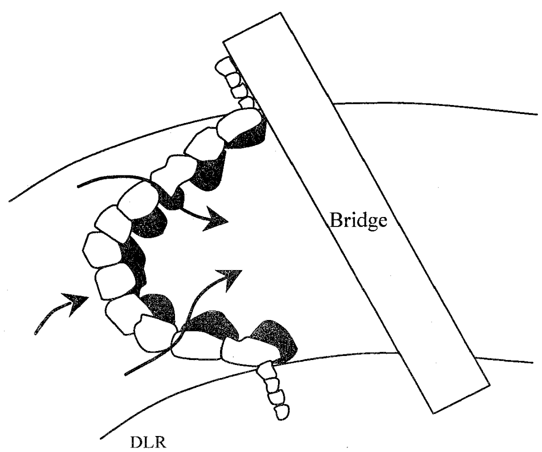

Figure 16. Application of a Cross-Vane for bridge and channel stability.

G5

center pier scour. Both the Cross-Vane and W-Weir can provide grade control, prevent lateral migration of channels, eliminate fish migration barriers, increase sediment transport capacity and competence and reduce footer scour. J-Hook Vanes can reduce bank erosion on outside banks both for the approach and downstream reaches of the bridge.

Streambank stabilization. The J-Hook Vane is designed to reduce accelerated streambank erosion on the outside bend of meanders. As a minimum, the amount of bank protected is 2 times the vane length, while maximum spacing provides approximately 3 times the bank protection to vane length. If both banks are eroding due to confinement (lateral containment) and entrenchment (vertical containment), then the Cross-Vane decreases the stream power and shear stress concurrently on both banks. This avoids lining or hardening both banks through a reach to provide protection.

Summary

The Cross-Vane, W-Weir and J-Hook Vane are structures that can be implemented to maintain or enhance river stability and function to facilitate multiple objectives. These structures have been successfully applied in natural channel design for river restoration, bank stabilization, grade control, irrigation diversions, fish habitat enhancement, bridge protection, and recreational boating. Continued monitoring will provide the information necessary to improve the designs to further their application to meet the ever-increasing demand for environmentally "softer" structures that meet multiple objectives.

Acknowledgement. The author wishes to thank J.D. Kurz for computer assisted graphics and field assistance along with Art Parola, Jeremy Mondock and Jean Kapusnick for the Cross-Vane map in Figure 4, and to Dr. Richard Hey and Owen Williams for their thorough technical review of this manuscript.

Bibliography

Bathurst, James C. 1979. Distribution of Boundary Shear Stress in Rivers. Adjustments of the Fluvial System. In Rhodes, Dallas D. and Garnett P. Williams (Eds.), Adjustments of the Fluvial System (pp. 95-116).

Bathhurst, James C., C. R. Thorne, and R. D. Hey. 1979. Secondary flow and shear stress at river bends. J. Hydr. Div. ASCE, 105(HY10), 1277-1295.

Derrick, David L., Pokrefke, Thomas J., and Boyd, Marden, B., Crutfield, James P., Henderson, Raymond R. 1994. Design and Development of Bendway Weirs for the Dogtooth Bend Reach, Mississippi River, Technical Report HL-84-10, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, Mississippi.

Derrick, David L. 1996. Harland Creek Innovative Bank Stabilization Demonstration Project. In 6th Federal Interagency Sedimentation Conference, March 10-14, Las Vegas, NV.

Hey, R.D. 1992. River Mechanics and Habitat Creation. In: O'Grady, K.T.O., Butterworth A.J.B., Spillet, P.B. and Domainiewsky J.C.T., Fisheries in the year 2000, Institute of Fisheries Management, UK, 271-285.

Ikeda, Syunsuke, Gary Parker, and Yoshitaka Kimura. 1988. Stable Width and Depth of

G5

Straight Gravel Rivers with Heterogeneous Bed Materials. Water Resources Research 24(5): 713-722.

Leopold, L.B., G.M. Wolman, and J.P. Miller, 1964. Fluvial Processes in Geomorphology W.H. Freeman and Co. San Francisco 522pp.

Odgaard A. J. and Mosconi C. E. 1987. Streambank protection by submerged vanes. Journal of Hydraulic Engineering. ASCE, 113(4), 520-536.

Paice, Colin and Richard Hey. 1989. Hydraulic control of secondary circulation in a meander bend to reduce outer bank erosion. In Albertson, M.L. and Kia, R.A. (Eds.), Design of Hydraulic Structures 89. (pp. 249).

Parker, G. 1978. Self-formed straight rivers with equilibrium banks and mobile bed, 2. The gravel River, J. Fluid Mech. 89(1), 127-146.

Rosgen, David L. 1994. A Classification of Natural Rivers, Catena 22, pgs. 169-199, Elsevier Science B.V. Amsterdam

Rosgen, David L. 1996. Applied River Morphology. Wildland Hydrology Books, Pagosa Springs, Colorado.

Rosgen, David L. 1997. A Geomorphological Approach to Restoration of Incised Rivers In: Management of Landscapes Disturbed by Channel Incision, Univ. Miss, Oxford, Miss. Pg 3-22.

Rosgen, David L. 1998. The Reference Reach – A Blueprint for Natural Channel Design. In Proceedings of ASCE Specialty Conference on Restoration, Denver, Colo.

Rosgen, David L. 2001. A Practical Method of Computing Streambank Erosion Rate. In 7th Federal Interagency Sedimentation Conference, March 25-29, Reno, NV.

COMMENT RESPONSE:

G5-1 The term Applicant's Proposed Project has been substituted for the term Applicant's Preferred Alternative throughout the document.

G5-2 The draft EIS does analyze the Preferred Alternative's option of allowing public access only west of a security gate at Gilles Creek, with only Pogo project-related use allowed east of Gilles Creek. The general drafting convention is that if an option would have no or only minor impacts on a particular resource, then the Chapter 4 section for that resource is silent concerning impacts. If the option would have greater than minor impacts on a particular resource, then those impacts are discussed under the heading "Security gate at Gilles Creek" for Alternative 2 in that resource's Chapter 4 section. Of the 16 applicable resource sections that discuss impacts in Chapter 4, 12 are silent because there would be no or only minor impacts, while 6 contain descriptions of impacts for a "Security gate at Gilles Creek," i.e., public use only allowed west of the gate.

G5-3 Thank you for your comment and technical paper. These will be considered during the State's permitting process.

G5-4 These suggestions will be considered by ADNR for its final Plan of Operations Approval which will be issued after publication of this FEIS.

G5-5 Table 4.20-1 presents just mitigation measures proposed by the Applicant for its proposed project, which includes only Pogo use of the entire road and reclamation of its entire length. Subsistence mitigation measures for the Preferred Alternative likely would be similar, but only for that portion of the road that would only be used by the Pogo project.

G5-6 Thank you for reconfirming the absence of threatened and endangered species in the project area.

G6

U.S. Department of Transportation
United States Coast Guard

Commander
Seventeenth Coast Guard District

P.O. Box 25517
Juneau, Alaska 99802
Staff Symbol: (oan)
Phone: (907) 463-2268
FAX: (907) 463-2273

16590
April 28, 2003

Hanh Gold
NEPA Compliance Coordinator
U.S. Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

RECEIVED MAY -1 2003 U.S. EPA REGION 10 OFFICE OF WATER

SUBJECT: Draft Environmental Impact Statement (DEIS)
Pogo Gold Mine Project, Delta, Alaska

Dear Ms. Gold:

We are forwarding information as discussed earlier in an effort to help you develop and evaluate navigational impacts on vessels if a bridge structure was constructed across the Goodpasture River near Delta, Alaska as proposed in the Pogo Gold Mine Draft Environmental Impact Statement. Describing the present navigation of the entire waterway and for the reach through the bridge site is the first step in this process.

I have enclosed several sources of information that may help you develop the draft EIS section dealing with navigational impacts. Other sources of information describing the present use of the waterway include the local offices (Delta) of the Alaska State Troopers, Alaska Fish and Game, State and/or Federal Parks Services, Native and Tribal offices, and various guided hunting, fishing and tourist services in Alaska that use the Goodpasture River. Thank you for the opportunity to comment on this important project. G6-1

James Helfinstine

J. N. HELFINSTINE
District Bridge Program Administrator
Aids to Navigation Branch
U.S. Coast Guard
by direction of the Commander

Enclosures: (1) Federal Contacts in Alaska for Navigability-Related Issues
(2) Navigational Evaluation

"Operational Excellence through Leadership, Teamwork, and Continuous Improvements"

G6

FEDERAL CONTACTS IN ALASKA FOR NAVIGABILITY-RELATED ISSUES

Army Corps of Engineers, Department of Defense

Mr. Hank Baij
U.S. Army Corps of Engineers
Alaska District
Regulatory Branch, Southern Section
P.O. Box 898
Anchorage, Alaska 99506
Ph: 753-2712
Fax: 753-5567
E-Mail: Harry.A.Baij@POA02.usace.army.mil

Irvin T. Joy (Skip)
U.S. Army Corps of Engineers
Regulatory Branch, Southern Section
P.O. Box 898
Anchorage, Alaska 99506
Ph: 753-2712
Fax: 753-5567
E-Mail: Irvin.T.Joy@POA02.usace.army.mil

Bureau of Land Management, Department of the Interior

Ralph Basner
Bureau of Land Management
Alaska State Office
Division of Cadastral Survey
222 W. 7th Ave., #13
Anchorage, Alaska 99513-7599
Ph: 271-3329
Fax: 271-4549
E-mail: rbasner@ak.blm.gov

C. Michael Brown
Bureau of Land Management
Alaska State Office
Division of Lands, Minerals and Resources
222 W. 7th Ave., #13
Anchorage, Alaska 99513-7599
Ph:271-3602
Fax:271-5479
E-mail:m2brown@ak.blm.gov

Susan DiPrete
Bureau of Land Management
Alaska State Office
Division of Cadastral Survey
222 W. 7th Ave., #13
Anchorage, Alaska 99513-7599
Ph: 271-4363
Fax: 271-4549
E-mail: sdiprete@ak.blm.gov

G6

Jack Frost
Bureau of Land Management
Alaska State Office
Division of Cadastral Survey
222 W. 7th Ave., #13
Anchorage, Alaska 99513-7599
Ph: 271-5531
Fax: 271-4549
E-mail: jfrost@ak.blm.gov

Frank Hardt, Riparian Specialist, Surveyor
Bureau of Land Management
Alaska State Office
Division of Cadastral Survey
222 W. 7th Ave., $13
Anchorage, Alaska 99513-7599
Ph: 271-3182
Fax: 271-4549
E-mail: fhardt@ak.blm.gov

Laura Lagstrom
Bureau of Land Management
Alaska State Office
Division of Cadastral Survey
222 W. 7th Ave., #13
Anchorage, Alaska 99513-7599
Ph: 271-3359
Fax: 271-4549
E-mail:llagstro@ak.blm.gov

Terry Hobbs
~~Lynette Nakazawa~~, Supervisor
Bureau of Land Management
Division of Cadastral Survey
222 W. 7th Ave., #13
Anchorage, Alaska 99513-7599
Ph: 271-3274
Fax: 271-4549
E-Mail:lnakazaw@ak.blm.gov

Dot Tideman
Bureau of Land Management
Alaska State Office
Division of Cadastral Survey
222 W. 7th Ave., #13
Anchorage, Alaska 99513-7599
Ph: 271-3611
Fax: 271-4549
E-mail: dtideman@ak.blm.gov

Coast Guard, Department of Transportation

Commander (mon)
Attn: Mr. James Helfinstine
P.O. Box 25517
Juneau, Alaska 99802
Ph:463-2268
Fax 463-2273
E-mail:jhelfinstine@cgalaska.uscg.mil

Lt. Commander ~~Steve McCleary~~
Coast Guard Marine Safety Office
510 L. St., Suite 100
Anchorage Alaska 99501
Ph: 271-6722
Fax: 271-6751
E-Mail: smccleary@cgalaska.uscg.mil

CWO3 Bennett (RON)
and ... M

G6

was mailed to them. A list of those owners should be included in the case file.)

( ) Yes ( ) No

c. **Date of Coast Guard Local Notice to Mariners:**

d. **Date of Coast Guard Public Hearing (if applicable):**

10. **Summary of views of governmental agencies, navigational interests or other interested parties:**

II. **NAVIGATIONAL EVALUATION** Give reasons to support each answer. Describe present and prospective navigation of the entire waterway and for the reach through the bridge site.

✓ 1. Do vessels engaged in emergency operations (i.e., law enforcement, fire, rescue, emergency dam repair, etc.), national defense activities (i.e., cruisers, fuel barges, munitions ships, etc.) or channel maintenance (i.e., dredges, dam and levee repair, etc.) operate on the waterway? If yes, describe the vessels and provide the following information:

a. Will the proposed bridge provide the horizontal and vertical clearances for the safe, efficient passage of the largest of these vessels? Why?

b. If no, estimate the number of vessels in each of the above categories unable to pass the proposed bridge. Give the name, length overall (LOA), beam, draft, height of highest fixed point above the waterline for vessels affected by the bridge.

c. Can these vessels be modified (i.e., folding mast, relocation of equipment, etc.) without decreasing their respective response times? If so, name the vessels.

d. If modifications are feasible, name the vessels, state the necessary modifications, the cost of modifying each, and who will pay for the modifications (i.e., vessel owner, applicant, other).

N/A 2. Has the Corps of Engineers completed or does it plan to complete a federal navigation project on the waterway? If yes, provide the following information:

a. Project name, downstream/upstream milepoints, depth, other limiting factors.

b. The following specifications of the vessel for which the navigation project is or will be designed: LOA, beam, draft, and height of highest fixed point above the waterline.

GL

c. Will the proposed bridge provide the horizontal and vertical clearances necessary for the safe, efficient passage of the vessel for which the navigation project was designed?

d. If no, can the vessel be modified to clear the proposed bridge without substantially increasing its operating costs?

e. If modifications are feasible, state the necessary modifications, their costs and who will pay for the modifications.

3. **Describe the present and prospective recreational navigation:** Will the proposed bridge affect the safe, efficient movement of any segment of the present or prospective recreational fleet operation on the waterway? If yes, provide the following information:

a. State the number of and the type of vessels which may be affected by the proposed bridge. Provide the LOA, beam, draft, and height of the highest fixed point above the waterline of each affected vessel. Estimate this percentage of the recreational fleet which may be affected by the proposed bridge.

b. Will the proposed bridge eliminate the access of these vessels to existing or planned commercial, water-oriented facilities (i.e., restaurants, shops, recreational areas, marinas, etc.) in the vicinity of the proposed bridge. Describe these facilities.

c. If yes, discuss the economic impacts the restriction will have on existing or planned commercial, water-oriented facilities.

d. Is it feasible to modify the affected segments of the fleet to clear the proposed bridge without substantially increasing operating costs? If yes, name the vessels, state the necessary modifications, cost of modifying each vessel and person or entity responsible for financing the modifications.

NOTE: Check with local Corps of Engineers District Office, Chamber of Commerce or other organizations for proposed marinas, recreational areas, shops, etc.

4. **Describe the present and prospective commercial navigation and the cargoes moved on the waterway:** Will the proposed bridge affect the safe, efficient movement of any segment of the present or prospective commercial fleet operating on the waterway? If yes, provide the following information:

a. State the number of and the type of vessels which may be affected by the proposed bridge. Provide the LOA, beam, draft, and height of the highest fixed point above the waterline for each of these vessels. Estimate the percentage of the commercial fleet which may be affected by the proposed bridge.

GL

b. Discuss the economic impacts the restriction will have on local commercial shipping. Discuss the economic input which supports the Commandant's and DOT's strategic goals.

c. Describe any existing or planned commercial or industrial developments (i.e., manufacturing, refining, facilities, etc.) and other businesses affected by this restriction, and discuss the economic impacts the restriction will have on each business.

d. Is it feasible to modify the restricted vessels to clear the proposed bridge without substantially increasing operating costs? If yes, name the vessels, state the necessary modifications, cost of modifying each vessel and company or entity responsible for financing the modifications.

5. Will the proposed bridge block access of any vessel presently using local service facilities (i.e., repair shops, parts distributors, fuel stations)? If yes, provide the following information:

a. Describe the facilities and estimate the number of vessels currently using these facilities.

b. Provide the following specifications of vessels which will be forced to seek alternate facilities: name, LOA, beam, drift, height of the highest fixed point above the waterline.

c. What economic impact will loss of access have on these facilities? Include the estimated dollar amount to support Commandant and DOT goals.

d. What is the distance to alternate service facilities capable of servicing the affected vessels? Describe the facilities.

e. Will use of these alternate facilities substantially increase vessel operation costs or downtime?

f. Is it feasible to modify the affected vessels to clear the proposed bridge?

g. If yes, state the name, necessary modifications, cost of modifying each vessel and who will pay for the modifications.

6. Are alternate routes bypassing the proposed bridge available for use by vessels unable to pass the proposed bridge? If yes, provide the following information:

a. State the number of vessels which will be forced to use alternate routes.

b. Describe those vessels by listing the name, LOA, beam, draft, height of the highest fixed point above the waterline for each.

c. Identify any alternate routes and provide the respective distances between the proposed bridge and these routes.

d. Will use of these routes substantially increase the transit time and/or operating costs of the affected vessels? This relates to the mobility goals of the Commandant and DOT.

e. If yes, describe the impacts of increased transit time and/or operating costs.

f. Is it feasible to modify these vessels to clear the proposed bridge?

g. If yes, state the name, necessary modifications, cost of modifying each vessel and who will pay for these modifications.

7. Will the bridge prohibit the entry of any vessels to the local harbor of refuge? If yes, describe the harbor and provide the following information:

a. What percentage of vessels currently using the harbor refuge will not be able to pass the proposed bridge to gain access to that refuge? Describe the vessels.

b. State the number of vessels, name, LOA, beam, draft, and height of the highest fixed point above the waterline for those vessels whose access to the refuge is prohibited by the proposed bridge.

c. Is it feasible to modify these vessels to clear the proposed bridge?

d. If yes, state the name, necessary modification, cost of modifying each vessel and who will pay for the modifications.

e. If alternate refuges are available, describe them and state the distance of each from the present harbor of refuge.

NOTE: A harbor of refuge is defined as a naturally or artificially protected water area that provides a place of relative safety or refuge for commercial and recreational vessels traveling along the coast or operating in a region.

8. Will the proposed bridge be located within one-half mile of a bend in a waterway? If yes, describe the bend and provide the following information:

a. Is there sufficient distance between the bridge and the bend to allow proper vessel alignment for the safe, efficient passage of vessels through the proposed bridge?

b. If no, what factors make construction of the bridge at an alternate location impractical?

9. Are there other factors (i.e., dockages, lightering areas, existing bridges, etc.) located within one-half mile of the proposed bridge which would create hazardous passage through the proposed structure? If yes, provide the following information:

a. Describe the factors:

b. What mitigative measures do you recommend? Why?

10. Do local hydraulic conditions (i.e., wave chop, cross currents, tides, shoals, etc.) increase the hazard of passage through the proposed bridge? If yes, provide the following information:

a. Describe the conditions:

b. What mitigative measures do you recommend? Why?

11. Do local atmospheric conditions (i.e., strong, prevailing winds, fog, rapidly developing storms, etc.) increase the hazard of passage through the proposed bridge? If yes, provide the following information:

a. Describe the conditions:

b. What mitigative measures do you recommend? Why?

12. Have guide clearances been established for the waterway? If yes, provide the following information:

a. Horizontal guide clearance:

b. Vertical guide clearance:

c. Do the proposed bridge clearances differ from these guide clearances?

d. If yes, which of the above factors (1 through 11) justify deviating from these guide clearances?

13. State any other factors considered necessary for the safe, efficient passage of vessels through the proposed bridge? Are clearance gauges needed? Why?

III. ENVIRONMENTAL EVALUATION

1. **NEPA considerations:**

a. Identify lead agency:

b. Identify cooperating agencies:

c. Type of environmental document (i.e., CE, FONSI, EIS, Reevaluation):

COMMENT RESPONSE:

G6-1 A description of the proposed bridge structure and construction procedures has been added at the end of Section 2.3.3. A new Section 3.5.5 (Vessel Navigation), and a new subsection at the end of Section 4.1.2 (Vessel Navigation), have been added to the document to describe existing navigational uses and impacts from the proposed road bridge near the mine site, respectively.

G7

U.S. Department of Transportation
Federal Aviation Administration

Alaskan Region
Air Traffic Division

222 W. 7th Avenue, #14
Anchorage, AK 99513-7587
Phone: (907)271-5464
Fax: (907)271-2850

APR 28 2003

RECEIVED MAY - 1 2003 U.S. EPA REGION 10 OFFICE OF ...

United States Environmental Protection Agency, Region 10
ATTN: Ms. Hahn Gold
1200 Sixth Avenue
Seattle, WA 98101

Dear Ms Gold:

Thank you for the opportunity to review the draft Environmental Impact Statement (EIS) for the Pogo Gold Mine Project. The primary issue for our Region, as it relates to this project, is the potential for significant environmental impacts associated with the airspace requirement for the Controlled Firing Area (CFA). With that in mind, we offer the following comments for your consideration.

CFA's are established to contain activities that are conducted in a controlled manner to prevent any hazard or impact to nonparticipating aircraft. Although there is no charted airspace designation involved, or any airspace reserved for the user, CFA's are technically classified as Special Use Airspace and require documentation under the National Environmental Policy Act (NEPA).

In order to satisfy NEPA requirements, documentation must assess the environmental impact of the airspace requirement. In other words, what impact will the CFA have on noise, air quality, visual impacts, wildlife, land use, socioeconomics, natural resources, Section 303 land, and any other pertinent impact category.

In a CFA, the user agrees to keep a watch for passing aircraft and immediately terminate the hazardous activity if an aircraft approaches the area; and to adhere to certain visibility conditions to ensure the ability to observe passing aircraft. Since CFA's are not published on aeronautical charts and aircraft are not required to deviate around them, CFA's generally impose no impact to aviation and therefore require no changes to flight tracks or operating altitudes that may change noise exposure levels. However, the EIS should document that the airspace requirement will not have a significant environmental impact. G7-1

A description of the proposed lateral boundaries, minimum and maximum altitudes, and times of use of the CFA should also be included in the document. G7-2

As a side note, on page 3-118, section 3.17.2, Federally Designated Military Lands, third paragraph, second sentence, the restricted corridor centered on the Goodpastor River is actually 4 miles wide, as opposed to 5. G7-3

2

Thanks again for the opportunity to participate in this effort. If you have any questions or need additional information, please contact Clarence Goward, Environmental Specialist, Operations Branch, at (907) 271-5883.

Sincerely,

Trent S. Cummings
Manager, Air Traffic Division

COMMENT RESPONSE:

G7-1 The CFA would be established for blasting purposes. Blasting generally is expected to have minimal impacts on the resources listed in the comment, and any expected effects are discussed under each specific resource discipline.

G7-2 Text in Section 2.3.18 has been expanded to reflect the comment.

G7-3 Text in Section 3.17.2 has been redrafted to reflect the comment.

STATE OF ALASKA

DEPARTMENT OF NATURAL RESOURCES

DIVISION OF MINING, LAND AND WATER

FRANK H. MURKOWSKI, GOVERNOR

550 WEST 7TH AVENUE, SUITE 900D
ANCHORAGE, ALASKA 99501-3577
PHONE: (907) 269-8629
FAX: (907) 269-8930

June 18, 2003

Hanh Gold, NEPA Compliance Coordinator
US Environmental Protection Agency
1200 Sixth Avenue, OW-130
Seattle, WA 98101

Dear Ms. Gold:

The Alaska Department of Natural Resources Office of Habitat Management and Permitting (OHMP) has reviewed the March 2003 Draft Environmental Impact Statement for the Pogo Gold Mine Project and the associated permits, and has the following additional comments. We have incorporated comments from the Alaska Department of Fish and Game's Divisions of Subsistence, Commercial Fisheries, Sport Fish, and Wildlife Conservation in the comments listed below.

G8

Alaska Department of Fish and Game-- Division of Subsistence

Page 2-38, Section 2.3.26, Fish and Wildlife Protection. Subsistence Division endorses the provisions in the applicant's preferred alternative that prohibit project personnel from hunting, fishing, and trapping in the project area unless they first return to their point of origin and return to the area. The policies proposed for inclusion in an employee education program should reduce the potential for problems with bears. We recommend that workers also be informed about the seasonal movements of the Fortymile Caribou Herd in the project area, and that steps be outlined, if necessary, for avoiding conflicts with the herd. As stated in the DEIS, caribou make only light use of the project area at this time (see p. 3-82) However, migration patterns can change and would need to be addressed should if caribou spend more time in the vicinity of project operations. G8-1

Section 3.18, Subsistence. The discussion of Upper Tanana Athabaskan subsistence practices in this section is detailed and informative, and provides more contextual information than often is presented in planning documents. The first paragraph of Section 3.18.1 distinguishes between subsistence uses in the project area by Natives and non-Natives communities, apparently because Native subsistence was defined as a scoping issue. Deciding to classify non-Native subsistence uses by residents of non-Native communities as recreation activities is contrary to how these uses are categorized in state law, which considers all Alaska residents eligible to be subsistence users in the project area. Eligibility for subsistence is not determined on the basis of ethnicity or place of residence in state statute. G8-2

One way to partially correct this deficiency is to explain that some of the fish and wildlife harvest activities described in Section 3.21, Recreation, may in fact be considered subsistence uses by the

"Develop, Conserve, and Enhance Natural Resources for Present and Future Alaskans."

individuals involved. Another option is to explain the basis for classifying these activities as recreational and commercial, rather than subsistence. Additional discussion is necessary so that the presentation in this document does not misrepresent the current legal definition of subsistence uses in state law. G8-2 CONT'D.

Section 4.13, Environmental Consequences: Subsistence. Following on the comments above, this section would more accurately evaluate the environmental consequences of the various alternatives on subsistence uses by expanding the assessment to include at least some of the uses by non-Native communities. G8-3 The next to last paragraph on page 4-139 states in part, "…and if the Applicant's no hunting and fishing policy were strictly enforced, impacts likely would not affect the overall pattern of subsistence uses." This implies that not enforcing the policy might be an alternative, which we hope the Applicant will reject as a viable option. If the policy is not going to be enforced, then other parts of the Environmental Consequences section will need to be re-evaluated. G8-4

Table 4.19.1, Summary of Cumulative Impacts, page 4-179. Some of the cumulative impacts presented for 4.12—Land Use, if an all-season road was maintained at mine closure, could also be categorized as impacts on subsistence uses, for reasons stated in our comments above. G8-5

Page 5-19, Table 5.1-3, Impacts Summary – Subsistence. Under Alternative 2, reference is made to the potential effects of opening the Shaw Creek Hillside all-season road to the public. Providing access across the Goodpaster River to recreationists and "sport hunters" is cited as a positive effect. Consistent with earlier comments, we suspect that some of the "sport hunting" activity in this area actually could be classified as "subsistence hunting" as currently defined in state statute. We again caution against misrepresentation of user group categories. G8-6

In summary, the Draft EIS effectively describes subsistence activities by Upper Tanana Athabaskan villages in the vicinity of the project area. However, it charts an unusual course in categorizing all other resource harvest activities in the area as being recreational, sport, or commercial in nature. This disregards the definition of who currently qualifies as subsistence users in state statute and may unintentionally misinform reviewers. Although the project area is not a major resource harvesting location for local residents, the actual effects on subsistence uses are misrepresented when some of the existing uses are miscategorized. The problems would be compounded if Pogo Mine operations expand over time and other development activities occur in the area and facilitate public access.

G9

Alaska Department of Fish and Game-- Division of Commercial Fisheries

(Page 4-88) **4.8.2 Gravel Sources-** Gravel pits are planned to be located in the floodplain with potential to trap juvenile chinook salmon (rearing) and to a much lesser extent outmigrating summer chum salmon after high water events. "Because the majority of spawning and likely juvenile use in the river for both Chinook salmon and grayling occurs downstream of the proposed gravel pits, impacts to the population should be low. Movement patterns of young-of the-year fish within the river, however, are unknown. These impacts could be mitigated by using crushed developmental rock, where feasible, to reduce the number and size of gravel pits, and by building perimeter berms around the gravel pits." The main gravel source (borrow) pits are to be located just upstream and downstream from the mouth of Wolverine Creek (located downstream of Pogo Creek) with G9-1

additional pits located near the 3000' airstrip upstream of Liese Creek (upstream from Pogo Creek). Both locations are within the Goodpaster River mainstem floodplain. Depending on distance of pits from the Goodpaster River and subsequent vertical elevation above OHW, the berms alone may not keep juvenile salmon or adult resident species from becoming trapped after high water events subside. Providing an outlet from these pits in addition to the perimeter berms (to prevent capture initially) could provide a means of allowing entrapped fish to return to the Goodpaster. Teck-Pogo should work with ADF&G and other state agencies to develop appropriate mitigation measures to minimize fish entrapment. Commercial Fisheries is particularly concerned with losing chinook salmon juveniles. From current information, the majority of chinook salmon do spawn below the gravel pits but a significant portion of them spawn in the proposed area and above. In 2002, 10 radio tagged adult chinook salmon were located near the mine site (Pogo Creek) or above it, and 11 were located below the mine. With movement patterns of juvenile chinook salmon within the river unknown, stating that impacts from the gravel pits should be low makes two assumptions; little spawning occurs near gravel extraction areas and juvenile chinook salmon do not move much within the drainage while rearing. It is known that significant spawning occurs in the areas already (and probably varies yearly), enough to be concerned about entrapment without knowing movement patterns of juveniles from other spawning areas not near the gravel pits. G9-1 CONT'D.

(Page 3-65) **3.13.1 Goodpaster River- Chinook salmon-** This section's first couple of paragraphs talks about aerial escapement methods, differences between helicopters and fixed-wing aerial surveys, and comparisons of the Goodpaster River chinook salmon run to the runs on the Chena and Salcha rivers. As stated: "However, this fixed wing aircraft survey method does not provide consistent indices of escapement due to variable weather, water conditions, timing, personnel, and section of river surveyed. The method has under estimated chinook salmon escapement by 71 percent in the Chena River and 57 percent in the Salcha River. Surveys using a helicopter or a boat provide a more consistent escapement index and better estimate total escapement in moderate to small-sized waters like the Goodpaster." These statements are correct, but the 71% in the Chena and 57% in the Salcha fixed-wing surveys were compared to tower counts, not helicopter surveys. To our knowledge, comparisons between fixed-wing and helicopters have not been done scientifically in Interior Alaska. Comparing total estimated escapements from towers on the Salcha and Chena Rivers to aerial index surveys whether from a helicopter or fixed-wing should not be done. Both aerial estimates are a snapshot of what is in the river at that time and does not represent the total escapement for the river surveyed. Helicopter surveys are affected by the same weather, water conditions, etc. stated above. Helicopters should give a more accurate number compared to fixed-wing aircraft given all the same conditions, but should not be used to attempt to estimate total abundance. Comparing towers to aerial surveys within the same river is reasonable, but comparing different systems (Chena and Salcha rivers) may downplay the size of the chinook salmon run on the Goodpaster River, making it look insignificant in comparison. In 2000, the Chena River had an estimated total escapement of 4,462 chinook salmon (tower estimate) while the Goodpaster River had an aerial estimate of 2,240 (helicopter survey). The 2,240 salmon on the Goodpaster River should be considered a minimum estimate, even though it was derived from a helicopter survey. With the Chena River being one of the largest (Salcha River the other) chinook salmon spawning rivers in the Alaskan portion of the Yukon River drainage, it appears that the Goodpaster River may contribute more to the drainage wide chinook salmon run than previously thought and may approximate returns to the Nulato River. G9-2

In 2002 (the EIS only covers work up to and including 2000) peak chinook salmon spawning was judged to have taken place on approximately July 20, which is 10 days earlier than stated as the approximate peak (August 1) in the EIS. If peak of spawning occurred on July 20, then entry into the Goodpaster more than likely was well prior to mid-July as stated as the time for first entry of chinook salmon into the river system. Furthermore, in 1998 a survey flown on July 15 counted 142 chinook salmon above Central Creek (Central Creek is approximately 61 miles from mouth) to the Eisenmenger forks near the headwaters. These chinook salmon had to have entered the river well prior to the stated entry date of mid-July. Entry times for migration and peak spawning will vary from year to year and should be noted as approximate times for upstream migration and peaks of spawning. Periodicity tables should be conservative to allow for varying run timing. Currently, upstream migration in the table (3.13-3) covers the 2nd to 4th weeks of July, and spawning the 4th week of July to the 2nd week of August. All of July should appear in the periodicity tables for upstream migration, and spawning should include the 2nd and 3rd weeks of July. G9-2 cont'd.

The lower ¾ mile of Wolverine Creek was found to be a chinook salmon rearing area. As noted in the gravel section, Wolverine Creek is the entry point to the Goodpaster River floodplain for all three proposed road routes. This entry point in conjunction with proposed gravel extraction near the creek may have impacts on future availability of this portion of the creek for rearing. Care should be taken with road and gravel pit work in this area. G9-3

(page 3-66) **Summer chum salmon.** Escapement information on summer chum salmon in the Goodpaster River is limited to observations made while assessing chinook salmon. Due to the later run timing, this information is minimal at best. The majority of observed summer chum salmon activity is below Central Creek and thus below the immediate mine site. But summer chum salmon would be subject to deleterious effects from downstream movement of spills, etc from the mine site. Chinook salmon were the major "indicator" species identified for study but chum salmon have a different life history. Since chum salmon life history specific to the Goodpaster River is lacking, it is unlikely the periodicity table for this species has as narrow a window (4th week of July to 2nd week of August for upstream migration and first three weeks in August for spawning) as in Table 3.13-3, and should be more conservative in scope. If the Salcha River is used as an example for upper Tanana River summer chum salmon stock timing, then the periodicity table should be extended at least into the beginning of September if not further. In 2001, approximately 850 summer chum salmon were counted past the tower in the Salcha River from September 1 through September 18. G9-4

Alaska Department of Fish and Game-- Division of Sport Fish G10

In summary, the resident and anadromous fish issues regarding this project have, in our opinion, been very well researched and addressed within the EIS. Regional and area staff reviewed pertinent sections of chapters 3 (3.5, 3.7, 3.12, 3.13, 3.18) and 4 (4.2, 4.3, 4.8, 4.13, and 4.16).

The Arctic grayling population that utilizes this drainage is complex and seasonally variable with components of the population contributing to numerous fisheries within the Tanana River Drainage. There are some natural impediments to boat access (log jams) that restrict fishing effort and therefore allow Shaw Creek to function as a refuge. However this has also restricted our efforts to G10-1

fully catalog the exact seasonal locations of Arctic grayling outside of the major drainage tributaries. We also have some concern regarding the paucity of data available for the other nine species of fish that are known to inhabit this drainage. We believe that with some attention afforded to catalog and inventory work our current concerns regarding distribution of fish species within the Shaw Creek drainage could be alleviated. The Shaw Creek route as described has five bridge crossings and 16 lesser stream crossings that will require culverts. The suggested catalog and inventory work is intended to fill gaps in our knowledge relative to the tributary streams and proposed crossings. This information could prove useful in culvert selection and installation for ensuring unimpeded fish passage. We hope to be able to work with Teck-Pogo during the project's life to collect additional data on the Shaw Creek drainage. G10-1 cont'd.

Alaska Department of Fish and Game-- Division of Wildlife Conservation G11

Chapter 3–Affected Environment

3.14 Wildlife

The no action alternative would have the fewest detrimental impacts on wildlife resources in the project area and is the preferred option from the wildlife perspective.

Wildlife within the Goodpaster River and Shaw Creek drainages are dependent on the aquatic ecosystem of these drainages. For example, riparian and wetland habitats provide important foraging areas for moose, predatory birds such as bald eagles and osprey are dependent on the fisheries for food, waterfowl are dependent on wetland water quality for foraging and brood rearing, furbearers such as river otters and mink are dependent on aquatic habitats for foraging, and there are many other examples. Therefore, one of the most critical aspects for DEIS review is the impact of the project on water quality.

3.14.1 Habitat Values

The discussion of wildlife habitats and their value to wildlife in the effected area is based on Jorgenson et al (2000)'s Conservation Priority Index (CPI) methodology. The DEIS states that a discussion of the methodology is beyond its scope. However, because the CPI is the basis for wildlife discussions, it should at least be included as an appendix in the DEIS so the public and agencies can effectively review and evaluate wildlife habitat issues with a clear understanding of the methodology. G11-1

3.14.3 Mammals

Moose: The DEIS states that moose are found primarily at low to mid-elevations. However, moose are also found at high elevations that contain some of the highest quality moose habitat in the affected area. G11-2

The DEIS states that most moose hunting in northern Game Management Unit 20D (GMU) occurs in the vicinity of Delta Junction and the Richardson Highway. However, the Goodpaster River downstream of Tibbs Creek is a major hunting area for northern GMU 20D. Mining activity that affects the drainage will impact a significant number of moose hunters in this area. G11-3

The DEIS fails to comment on the long-term impact to moose populations from mine development in the area. Although the density of moose in the area is relatively low at this time, the Alaska Board of Game has adopted intensive management for this area with the intent of increasing the number of moose for human consumption. The presence of the Pogo mine and other possible mining activities will cause a more conservative approach in wildfire suppression and will likely reduce the potential for increasing the number of moose within the effected area. To mitigate for potential negative impact on moose population growth, Teck-Pogo, Inc. could assist the state with prescribed wildfire burns in the Shaw Creek drainage for conversion of black spruce forest into moose browse. This would also benefit wolves and bears that prey on moose, as well as help meet the Alaska Board of Games goal to increase moose populations for human consumption. Teck-Pogo should also construct fire breaks around their facilities, and wrap powerline poles in fireproof material, so that naturally occurring wildfires can be allowed to burn without endangering mine facilities and necessitate extinguishing naturally occurring fires. G11-4

Discussion of moose harvest in the DEIS reports data for 9 Uniform Coding Units (UCUs). The Goodpaster River and Shaw Creek drainages are covered by 5 UCUs and it is not clear which additional 4 UCUs are included. G11-5

The DEIS reports that since 1984 annual moose harvest in the Goodpaster River averages 18 moose/year. This data is an underestimate for recent years. Since 1992, Goodpaster River moose harvest in UCUs 300 (nonspecific Goodpaster River), 301 (lower Goodpaster River), 302 (upper Goodpaster River), and 303 (Eisenmenger Fork) has averaged 28 moose/year by an average of 114 hunters/year. G11-6

Wildlife Conservation staff have been told by Teck-Pogo staff that their employees will not be allowed to hunt, trap, or fish while at the camp. To reduce the impact of increased moose hunting or trapping in the area, Teck-Pogo should also prohibit their employees from hunting in the area while off-duty without first returning to their home location. G11-7

Caribou

Herd estimates used in the DEIS are outdated. The Fortymile herd numbered about 45,000 caribou in fall 2002. The continued increase is still due to the causes listed in the draft. G11-8

The DEIS states that calving takes place well to the north and east of the claim block. The important information for Pogo is that the mine is located away from calving habitat. However, calving commonly takes place within 20 miles in areas that are being actively explored for minerals. Any development of future discoveries most likely would want to take advantage of the transportation and power corridors to Pogo. There needs to be some treatise of how these in place transportation corridors will be used as these decision could have much greater effects on the Fortymile herd. G11-9

The DEIS states that the claim block lies southwest of areas used by radio collared female caribou of the Fortymile herd during all seasons except rut and winter. However, this represents one-half of the year and is therefore of critical importance. Fortymile caribou use of the Goodpaster River will probably increase as herd size increases. This area contains a mosaic of habitat types offering preferred forage species throughout the year. G11-10

Brown Bear

Human activity and development generally have overall negative impacts on large predators such as black bears, brown bears, and wolves, resulting in reduced numbers of these species. Therefore, a reduction in these species should be anticipated in the effected area.

The DEIS should note that brown bear habitat in northern GMU 20D does include lowlands as well as uplands and is verified by reports in the DEIS that brown bears have been observed by Pogo-Teck staff at the lowland camp. G11-11

Population data for brown bears reported in the DEIS is 92 bears $\geq$2 years old for northern GMU 20D. The actual estimate is 92–109 bears. The DEIS also states that bear densities in northern GMU 20D are low relative to other subunits in GMU 20, however, that is not the case in northern Unit 20D where the density is probably near natural densities. G11-12

A typographical error in the DEIS reports the moose calf survival objective to be 30 calves:1000 cows instead of 30 calves:100 cows. G11-13

The DEIS inaccurately states that attempts to increase brown bear harvest in northern GMU 20D have been largely unsuccessful. However, these efforts have actually been moderately successful with mean annual harvest increasing from 1 bear/year to 3 bears/year and the range of annual harvest increasing from 0–2 bears/year to 1–7 bears/year in the last 7 years with more liberal hunting regulations. Harvest was probably not high enough to cause a population reduction but as the number of hunters increase, bear harvest is also expected to increase and could exceed sustainable. G11-14

A recent observation by Wildlife Conservation staff of brown bears feeding on chinook salmon in the Goodpaster River should be included in the DEIS. As the number of fish in the chinook salmon run increase as noted in Table 3.13–1, this resource will become increasingly important to bears. There is an abundance of literature that discusses the importance of salmon streams to interior grizzly bear populations. Factors that may degrade river water quality or salmon habitat would also negatively impact bears. G11-15

The DEIS states that garbage will be incinerated to prevent bears and other wildlife from feeding on it. An additional mitigating action that may be necessary around highly aromatic sites is the construction of electric boundary fences to discourage bears from visiting the sites. G11-16

Wolf

Human activity and development generally have overall negative impacts on large predators such as black bears, brown bears, and wolves, resulting in reduced numbers of these species. Therefore, a reduction in these species should be anticipated in the effected area.

The DEIS states that 1–2 packs have been known to range in the project area. This wording implies that wolves occasionally use the area. If the project area includes the road access route through the Shaw Creek drainage, the area includes 2–3 permanent packs, with the possibility of additional single wolves or pairs. G11-17

Wolves using the den site noted near the vicinity of Indian Creek will likely abandon the site as mine and airstrip development increases in the area. G11-18

Furbearers
Several furbearer species including mink, river otter, beaver, and muskrat use aquatic habitats that will be directly impacted by water quality of the Goodpaster River and Shaw Creek. Wildlife Conservation staff recognize that water quality is a critical aspect of the DEIS but do not have adequate expertise to evaluate water quality issues and are depending on the Environmental Protection Agency and Alaska Department of Natural Resources to review and evaluate these aspects of the DEIS.

Furbearer species that are sensitive to disturbance from human activity will be displaced from the area and their habitat will be fragmented. These species include wolverine, lynx, and marten. G11-19

The DEIS should discuss lynx in the furbearer section. G11-20

Chapter 4–Environmental Consequences
4.9.2 Options Common to All Alternatives
The DEIS states that habitat loss for birds and mammals will generally be low. However, it should be noted that the overall effect for the area will be a cumulative loss of wildlife habitat for a number of different species that could be exacerbated with additional future development in the area. G11-21

The DEIS discusses the potential for black bears being attracted to garbage, however, it should be noted that brown bears will also be attracted. G11-22

4.9.3 Options Not Related to Surface Access
Alternative 2 and 3: Power Line
The public will likely use the proposed power line right of way for ATV access into the area. Thus the power line will provide public access into a remote, relatively inaccessible area, regardless of road access status. The greatest wildlife impact will result from increased use by moose, caribou, and bear hunters resulting in increased harvest for these species. More restrictive hunting regulations will likely be required to compensate for increased access and harvest. G11-23

4.9.4 and 4.9.5 Options Related to Surface Access and Cumulative Impacts
Wildlife Conservation concurs with the DEIS that "the absence of an all-season road would reduce direct and indirect impacts on wildlife, particularly caribou" and support this option.

However, recognizing that construction of an all-season road is likely, we recommend Surface Access Route Alternative 2, the Shaw Creek Hillside all-season road. The Shaw Creek Hillside route will have the least impact on high quality moose and caribou habitat. Any route however, will increase hunter access into the area via the road or the accompanying power line and will necessitate a review of hunting and trapping regulations and likely further restrictions. We expect especially during the winter, high public use of this road for caribou hunting increasing conflict between industrial use and hunters. We recommend that the road and adjacent powerline be closed to public access during the life of Pogo mine. G11-24

An all-season road will likely provide access to other potential mine sites such as Sonora Creek, Slate Creek, or others. Although the DEIS states that the direct loss of wildlife habitat from additional mining activity is low relative to each site, it should be noted that the cumulative effect of these activities will further reduce wildlife numbers and diversity within the area. G11-25

Thank you for the opportunity to provide comments. If you have any questions, please contact me at 907-269-8629.

Sincerely,

/S/

Ed Fogels
Large Mine Project Manager

Cc (by e-mail):
Victor Ross, ACOE
Mike Smith, Baker
Karl Hanneman, Teck-Pogo
Jack Winters, DNR OHMP

COMMENT RESPONSE:

G8-1 Thank you for your comment.

G8-2 The text in Section 3.18.1 has been redrafted to reflect the comment.

G8-3 The text in Section 4.13 has been redrafted to reflect the comment.

G8-4 The Applicant intends to implement an employee no hunting or fishing policy (Section 2.3.26).

G8-5 The impacts presented for land use at 4.12 in Table 4.19.1 do affect subsistence impacts as discussed at 4.13 immediately following in the same table.

G8-6 The text under Alternative 2 at 4.13 in Table 5.1-3 has been redrafted to reflect the comment.

COMMENT RESPONSE:

G9-1 The text in Section 4.8.2 has been redrafted to reflect the comment.

G9-2 The text in Section 3.13.1 regarding chinook salmon has been redrafted to reflect the comment.

G9-3 Thank you for your comment.

G9-4 The text in Section 3.13.1 regarding chum salmon has been redrafted to reflect the comment.

COMMENT RESPONSE:

G10-1 Thank you for your comment.

COMMENT RESPONSE:

G11-1 A new Appendix A.3 has been added to describe the Conservation Priority Index methodology.

G11-2 Text in Section 3.14.3 has been redrafted to reflect the comment.

G11-3 Text in Section 3.14.3 has been redrafted to reflect the comment.

G11-4 Text has been added to Section 4.9.2 to reflect the comment.

G11-5 Text in Section 3.14.3 has been redrafted to reflect the comment.

G11-6 Text in Section 3.14.3 has been redrafted to reflect the comment.

G11-7 The reader is referred to Section 2.3.26.

G11-8 Text has been added to Section 3.14.3 to reflect the comment.

G11-9 The reader is referred to Section 4.9.5.

G11-10 Text in Section 3.14.3 has been redrafted to reflect the comment.

G11-11 Text in Section 3.14.3 has been redrafted to reflect the comment.

G11-12 Text in Section 3.14.3 has been redrafted to reflect the comment.

G11-13 Text in Section 3.14.3 has been redrafted to reflect the comment.

G11-14 Text in Section 3.14.3 has been redrafted to reflect the comment.

G11-15 Text in Section 3.14.3 has been redrafted to reflect the comment.

G11-16 The reader is referred to Section 2.3.15.

G11-17 Text in Section 3.14.3 has been redrafted to reflect the comment.

G11-18 Text in Section 4.9.2 has been redrafted to reflect the comment.

G11-19 Text in Section 4.9.2 has been redrafted to reflect the comment.

G11-20 The reader is referred to Section 3.15.

G11-21 The reader is referred to Section 4.9.5.

G11-22 Text in Section 4.9.3 has been redrafted to reflect the comment.

G11-23 Text in Section 4.9.3 has been redrafted to reflect the comment.

G11-24 Thank you for your comment.

G11-25 Text in Section 4.9.5 has been redra